ANNUAL REPORT

——OF THE——

TERRITORIAL GEOLOGIST,

——TO THE——

GOVERNOR OF WYOMING.

—JANUARY, 1890.—

LOUIS D. RICKETTS, D. Sc.

TERRITORIAL GEOLOGIST.

CHEYENNE, WYO.
THE CHEYENNE DAILY LEADER STEAM BOOK PRINT
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CHEYENNE, WYO., January, 1890.

SIR—In accordance with the Statutes of Wyoming, I have the honor to transmit herewith a report of the results of the examinations and observations made by me upon the Economic Geology and Mineral Resources of this Territory during the past two years.

Very Respectfully, Your Obedient Servant,

LOUIS D. RICKETTS,
Territorial Geologist.

To His Excellency, Francis E. Warren, Governor of Wyoming.

INTRODUCTORY.

The writer of this report devoted the larger portion of the summer and fall of 1888 to visiting many widely separated localities in Wyoming, and making hasty reconnaissance of the ground to discover their respective mineral resources and probable merits. With team and wagon, sections of Carbon, Albany, Laramie, Fremont, Johnson and Crook counties were traversed. During the past season, portions of the same country were revisited, and more carefully viewed, and some of the Territory in the vicinity of the Union Pacific Railway was examined, especially the coal seams near the various mines. In all, between 5,000 and 6,000 miles were traveled overland, and a great distance by railway. In this work attention was chiefly given to coal and iron deposits, which are among the most important resources of the Terrritory, and are the principal subjects of this report. The petroleum fields were quite fully treated two years ago, and those interested in this product have copies of that report. Accordingly, the chapter on petroleum only embraces notes upon recent development, together with a description of localities not hitherto officially given attention. Little has been done with soda recently, and no new information has been gathered during the past two years. As it is of considerable prospective value, and is attracting more attention than formerly, a synopsis of the chapter in the last report has been inserted in this, embracing a classification of the deposits, analyses and other information.

Much time has been spent in collecting data for the preparation of a geological map of Wyoming. A large part of Carbon county and portions of Laramie, Albany, Fremont, Crook and Johnson counties have been examined and notes made by reference to Government corners, sufficient for a map of these areas. This undertaking is very important, as all geological maps published, excepting those of the survey of the fortieth parallel, have no claim to accuracy. All of this research is lost to this report, but will be handed down in office records and will be available in the future.

As the population of the Plains east to the Missouri River is rapidly increasing, and as freight rates upon railways are being reduced, mineral resources hitherto considered unimportant are now attracting attention. Among these are building stones, marble, fire clays, pottery clays, gypsum, and low grade ores of various kinds. Only casual mention of a few of these deposits can be made here. In the near future they should be investigated carefully, and tested to determine their values and the uses to which they are adapted. The undertaking is an arduous one, but will

be well worth the labor, as it will be found that the bulky mineral products, including fuels, will become the great factors of prosperity to Wyoming. Their winning from the earth will not only in itself continue to prove profitable, but they will indirectly enrich the agricultural sections by providing a home market for farm products. The districts containing gold, silver and other metals should also be examined.

The importance of bringing the newest information regarding our mineral resources before the public authoritatively, can only be properly appreciated by one who receives many letters asking for such data. It is respectfully recommended that arrangements be made by which the Geologist may publish bulletins upon special mineral deposits from time to time during the adjournment of the Legislature. Bulletins should be brief and the information contained in them should be included in the regular biennial report.

The plates inserted at the end of this report, illustrating the occurrence of coal in the seams, were drawn by Mr. H. Von Wedell. Construction of several other plates, illustrating the occurence of Hartville iron ores and other deposits, was rendered impossible by the sudden and lamentable death of Mr. Von Wedell.

The writer wishes to acknowledge his appreciation of the kindness and courtesy universally shown him by citizens in all parts of the Territory. He wishes to especially acknowledge the valuable information and assistance received from Messrs. Newell Beeman, A. E. Bradbury, and Mr. Ramsey of Almy; Messrs. Thos. Middleton, George L. Black, P. J. Quealey, Mark Hopkins, and John Ludvigson, of Rock Springs; Chas. E. Blydenburgh, E. M. and Malachi Dillon, of Rawlins; Messrs. L. R. Meyer and George Haywood, of Carbon; Hon. S. W. Downey, of Laramie; John S. Harper, of Sundance; Hon. George T. Beck, of Beckton; Hon. Mike Murphy, of Dallas, and many others.

CHAPTER I.

THE DEVELOPED AND UNDEVELOPED COAL LANDS OF WYOMING.

SECTION I.—INTRODUCTORY.

The well developed and regularly shipping coal mines of Wyoming are all upon the line of the Union Pacific Railway.

The situation of these mines and their connection by railroads of easy grades, as compared with many of the Colorado lines, enables them not only to supply the large market west and east along the main line of the Union Pacific, but allows them to send coal into Eastern Colorado, Southern Nebraska and Northern Kansas. For this reason there is room for a large expansion of their trade; but, with the exception of a portion of Montana, they can never have a natural market in the district between the 95th and 115th meridians, and north of the 42nd parallel, unless the region to the north of the railway limits fails to supply good

coal. The demand for a cheap fuel in this region is constantly increasing and has finally become so imperative that it will warrant a large outlay of capital. With the extension of railroads to the northwest from the east, and the consequent settlement of the country, fuel was brought from the eastern mines with which the lines connected. It is only now that they have advanced so far westward that the opening of new and large coal mines has become a matter of necessity. Although the available coal fields of the northwest are not well known or developed, yet the large amount of preliminary exploration already made has tended to show that coal adapted to the demands of commerce must be largely supplied by Wyoming.

The progress made in the coal mining industry in recent years is very great. Despite the fact that the output for the calender year 1889 is not much in excess of that for the preceding year, there has been a pressing demand for the coal, and the production would have been much greater but No. 4 mine of Almy was unexpectedly abandoned in November, 1889, and the Union Pacific coal department had no other mine in operation there and was practically forced to cease shipping from that place until the new mine (No. 7) was opened and equipped for a large output. No. 6 mine of Carbon has also been closed during a greater portion of the year and No. 2 mine alone has been producing, so that the output at this town has been greatly curtailed during 1889. From these causes the decrease in output of the Union Pacific mines at Almy and Carbon has been over 200,000 tons. The deficiency has largely been made up by the increased shipments from Rock Springs.

The production of coal during the past four years has been:

Year.	Short tons.
1886	829,355*
1887	1,170,318*
1888	1,409,506
1889	1,412,958

The advancement of this industry is more forcibly shown by the number of mines that have recently been opened. In January, 1888, there were 12 mines shipping coal by rail. Since that time, in November, 1888, one of these was abandoned, as already stated. On the other hand, 12 new mines have been opened and prepared for shipment by rail during the same period. Consequently, while there were but 11 shipping mines in January, 1888, there are just double that number in operation to-day. Most of the new mines have by no means reached the capacity proposed for them, or that their hoisting works admit. Few of them have made shipments yet. Some of them have been opened along other roads than the Union Pacific and have a different market. In view of these facts it seems certain that a still more marked increase in production may be looked for in the next few

*Mineral Resources of the United States, calendar year 1887.

years. The table inserted opposite page 12 shows the mines now shipping coal by rail and their actual or proposed capacity, together with other information.

The coal lands developed by these mines form a very small portion of the total coal area of Wyoming. Coal, in its broadest sense, is very widespread in its occurrence; it not only appears in many separate fields, but these fields are usually of very great extent. In the aggregate, the surface actually underlaid by coal bearing strata cannot fall short of 30,000 square miles. But some of this immense area lies so far beneath the surface that it is out of reach of the miner, and of the remainder many thousand square miles are of little economic importance on account of the inferior quality of the coal, and the ground is more valuable for agricultural (even for grazing) purposes than it will ever be as coal land. There remains, however, large areas of coal land capable of furnishing a practically inexhaustible quantity of excellent coal; and this not only includes the area controlled by the Union Pacific, but other areas north of its line which can and will satisfy the demands of the Northwest for cheap fuel. The railroads will only be called upon to exercise ordinary intelligence in the selection of lands and to recognize the fact that they must go to good coal; it will not come to them.

As there is a manifest demand for good coal, and since the inferior grades are practically worthless, it is a matter of great importance to define the areas where the better grades may be found. The writer has spent much time the past two summers in examining the Wyoming fields with this object in view. It is recognized that the laws governing the occurrence of coal in the western measures are not well understood, and that deductions drawn are narrow in their application. It has been thought best to confine this chapter closely as possible to a description of the quality and mode of occurrence of the coal at various places, as shown by actual developments, together with analyses and statistics of output. It is hoped by this method that inferences may be drawn by the reader regarding the coal seams in undeveloped localities.

SECTION II.—THE ALMY MINES.

These mines are in the southwestern corner of Uinta county near the Utah line. The Eocene rocks covering the greater portion of this region, have been entirely scored away, and the Laramie coal measures are exposed over a small area along the east side of Bear River. The river drift covers the coal droppings towards the South, but they appear near the surface in section 8, township 15, range 120, and may be traced thence North for nearly five miles. Beyond they again disappear beneath flat lying strata of younger rocks. The width of the belt along an East and West line varies considerably, on account of the deep gulches tributary to Bear River from the East. These expose the Laramie rocks for several miles back, while the Eocene

rocks partially form the hills lying between. Near the southern end of this area, the coal measures have a dip of from 25° to 30° East, and a strike of South 30° East. Toward the North the dip gradually decreases near the outcrop of the coal seams, and the strike rapidly changes to nearly due South. About 4.5 miles north of section 8, the strata lies almost horizontal, but a mile or more east of the outcrop of the coal seams at the last named point the dip rapidly increases to the eastward, and outcropping ledges in Red Canyon show the bedding plains standing almost vertically.

There are in all at least five seams of coal, of which but one is clean enough to work. Two of them are said to be about fifty feet apart, and the lower to be about 100 above the seam on which the mines are located. The upper is said to be nine feet thick, the lower about six feet, the measurements including the numerous bands of slate the seams contain. From eight to twenty feet below the seam worked there is a small seam from four to six feet in thickness, and from seventy to 100 feet below it there is another seam from eight to twelve feet thick. While the latter usually contains so many bands of slate, that it is of no practical value, yet I am informed that towards the South it is prospectively capable of furnishing good coal.

The strata containing the coal are characteristic of the Laramie group. Soft sandstones and argillaceous rocks, with numerous, but rather thin beds of hard, firmly bedded reddish yellow sandstone, are the most common.

The great seam from which the Almy coal is mined has been opened up and developed along the entire line of crop. The first mine was opened near the southern end of the field, the last near the northern. In the brief description given below I will begin at the northern end of the field for reasons which will be obvious hereafter.

An opening upon the northeast quarter of section 18, township 16, range 120, shows the seam to be about twelve feet in thickness, and to consist of a little more than a stratum of carbonaceous shale. To the South the thickness rapidly increases by the widening out of the bands of coal between the slates, and the seam assumes a number of features which render it very interesting. Almy mine No. 7, belonging to the Union Pacific Railway, lies south of section 18. Although the mine is scarcely a year old, the main slope is 1,700 feet in length, and entries aggregating many hundred feet in length have been driven. The slope runs a little north of east and has an average inclination of about 5.5°. Near the surface the dip is from 7° to 8°, but it flattens towards the face, evidently, however, only a local flattening, as evinced by the apparent great increase in dip shown up Red Canyon.

An upraise was made at the pump station, 150 feet south of the main slope, at a point 1,500 feet from the surface, to de-

termine the structure of the seam. The floor is an impure fire clay, merging into an argillaceous sandstone. The roof is clay shale that changes into an impure sandstone. The following measurements, beginning at the top of the seam, were given me. They were taken at the time the upraise was made:

No. of band.	Nature of band.	Thickness.
1	Coal	4 inches
1, *a*	Slate	2 "
1, *b*	Coal	4 "
2	Slate (white band)	4 "
3	Coal	1 foot 6 "
4	Fire clay	5 "
4, *a*	Slate	3 "
5	Coal	4 "
6	Slate	9 "
7	Coal	3 feet 6 "
7, *a*	Slate	1.5 "
7, *b*	Coal	3 feet 8 "
8	Slate	6 "
9	Coal	6 "
9, *a*	Slate	2 "
9, *b*	Coal	1 foot
10	Slate	5 inches
11	Coal	5 feet 4 "

Figure 1, Plate 1, represents a section constructed from these measurements. The important bands are those having separate numbers. Those marked by a repeated number, as 1, *a*, are not persistent and have no marked peculiarities.

The section is taken on a north and south line near the center of the mine and a little more than one mile from the opening upon section 18 just described. In mining the coal is taken from bands 7 to 11 inclusive. At the section point these have an aggregate thickness of about 15 feet. North of th slope this thickness rapidly decreases and is probably not over 11 or 12 feet 1,000 feet north. South of the slope it increases and is fully 20 feet 2,000 feet. The slate is, of course, separated in mining, but it has to be hoisted to the surface together with all slack, as the gob soon suffers spontaneous combustion.

No. 5 mine belongs to the Rocky Mountain Coal and Iron ing Company. It lies south of No. 7 mine. The two slopes are about a mile and a quarter apart. The main slope of the latter mine runs directly east with the dip. It has an average inclination of 13° and is about 1,500 feet in length. Unlike the method adopted at No. 7 mine the slopes and entries are made in the center of the coal worked, and in starting a room they run level until the floor of the coal is reached and then rise with the pitch. Also, on account of the great height of the coal, the rooms are run their length at a height of only 15 or 16 feet and then are mined back on the coal remaining in the roof. As in No. 7,

they take out all coal up to band No. 6. A section of the seam, as shown in this mine, is given in Fig. 2, Plate I. The following is the order of the various bands, as shown in this mine:

No. of band.	Nature of band.	Thickness.
1	Coal	4 feet
2	Slate	5 inches
3	Coal	2 feet
4	Fire clay	1 foot 3 inches
5	Coal	5 inches
6	Slate	9 inches
7	Coal	8 feet
8	Slate	6 inches
9	Coal	2 feet
10	Slate	3 inches
10, *a*	Coal	4 inches
10, *b*	Slate	3 inches
11	Coal	10 feet

It would appear that band No. 10 of Fig. 1 has split into two bands (10 and 10, *b*), with a narrow band of coal between them. The increase in the thickness of the fire clay band (No. 4) is very marked.

No. 6 mine, belonging to the owners of No. 5 is opened by a slope starting about half a mile northwest of the head house of No. 5 mine. This necessarily indicated a westward swing of the outcrop of the seam from its normal course of north and south, and might be explained either by a fault or a local swing of the strike to the northwest. Development showed that the phenomenon was caused by a fault of about 105 feet displacement, which was struck about 600 feet down the slope. As the fault was an upthrow to the East the slope struck through it into the very impure and bony seam twelve feet in thickness, which here lies 104 feet beneath the main seam. It is unnecessary to say that the management were at first considerably puzzled over the apparent decided change in the character of their coal, but they soon discovered the cause and developed the ground above the fault by an entry from No. 5 mine. It was found that the fault had a course nearly due north and south, and that it rapidly decreased in displacement towards the south, so that although the main slope of No. 5 crossed the line of the fault there was no fault observed. A cross cut from an entry from No. 5 mine, to a point about midway between Nos. 5 and 6 shows the fault to have there a displacement of less than fifty feet. Of couse the seam east of the fault does not outcrop for a considerable distance from the point where displacement first begins, but comes directly against rock in places on the downthrow side. Ultimately, however, it does appear at the surface in the No. 7 outcrop.

A similar fault, beginning as a mere fissure in No. 5 mine near the outcrop and just south of the slope, assumes towards

the southeast a displacement with a downthrow to the west. It is a fault of forty-five feet a quarter of a mile south of the slope. Further south it is said to decrease, and to have a throw of but twenty feet where cut by No. 4 slope, and to disappear a short distance beyond.

A third fault, with a throw down to the west, appears to lie just west of No. 6. It has never been developed.

The mines south of No. 5 have all been abandoned, and it is impossible to enter them. No. 4, belonging to the Union Pacific, was abandoned in the fall of 1888 on account of a creep and the presence of fires, which, on account of the explosive gases the seam generates, rendered working dangerous. The main slope is about 2,500 feet in length. It runs on the dip at an inclination of 15°, and has a course about 15° north of east.

Fig. 3, Plate I, represents a section of this seam as exposed in the workings of No. 4 mine. I am indebted to Mr. George L. Black, Assistant Superintendent of the Union Pacific coal mines, for this section and the following table of measurements:

No. of band.	Nature of band.	Thickness.
1	Coal	4 feet 7 inches
2	Slate	3 "
3	Coal	2 feet
4	Fire Clay	3 feet 6 "
5	Coal	6 "
5, *a*	Slate	4 "
5, *b*	Coal	2 feet
6	Slate	3 "
7	Coal	8 feet 10 "
8	Slate	6 "
9	Coal	1 foot 5 "
9, *a*	Slate	1.5 "
9, *b*	Coal	1 foot 2 "
10	Slate	2 "
10, *a*	Coal	8 "
10, *b*	Slate	2 "
11	Coal	10 feet

Old No. 2 mine of the company owning No. 5 is about one-half a mile southeast by south of No. 4. I am indebted to Mr. Newell Beeman, of Evanston, for the section of the seam as shown in this mine (Fig. 4, Plate I). The similarity of this section to the preceding is at once seen, but it will appear that No. 4 band has now widened to almost seven feet; also, we have in place of band No. 2, which was only three inches thick where encountered in No. 4 mine, a stratum of sandstone seven feet in thickness.

Union Pacific No. 3 mine is about 1.5 miles southeast by south of No. 4. The seam dip has increased to 25°. The strike has changed to about south 60° east. I am indebted to Mr. Black for the section of the seam worked in this mine (Fig. 5,

Plate I). It appears as if another band of fire clay enters into the seam between bands Nos. 7 and 8. This would sustain the opinion of Mr. Bruee, for many years a foreman of Almy mines, who told me of this band of clay appearing in the mine, and that, in the most southerly workings it rapidly widened and attained a thickness of eight or nine feet.

It is to be regretted that the abandonment of the mines along the greater portion of the outcrop of the Almy seam has prevented the collection of samples from all for analysis with a view to showing the variations in the quality of the coal. It is the opinion of the largest consumers of the coal, and no better evidence could be adduced, that there is a regular variation in the quality. It is said that the coal formerly produced by the Union Pacific's No. 4 and the Rocky Mountain Coal and Iron Company's No. 2 mines was the best for all purposes and that the quality gradually deteriorates, both to the north and south. The analysis of samples taken by the writer from Nos. 5 and 7 indicates this change as far as they apply.

These samples were taken from No. 5 mine; the results obtained were:

	1.	2.	3.
Water	9.93	9.91	10.03
Gas	39.63	40.01	39.10
Fixed carbon	43.16	42.90	42.82
Ash	7.28	8.05	8.05

No. 1 represents an average of the upper band (No. 7) of the portion of the seam worked, 2 represents an average of the lower (No. 11), 3 represents an average of all the coal worked. The samples were taken October 30, 1889, and the analysis were made a week later.

Two analysis were made of samples taken from No. 7 mine:

	1.	2.
Water	11.98	11.78
Gas	38.35	38.31
Fixed carbon	41.76	42.04
Ash	7 91	7.87

The first analysis given represents a sample of the bottom band (No. 11); the second of all coal worked. The samples were taken and the analysis made on October 30, 1889, and a week later, respectively.

From the description of the Almy seam given above it appears that it begins on the northern exposure of the outcrop as a small stratum of shale, but the bands of coal rapidly widening, it soon becomes workable; that the seam continues to increase in thickness until it reaches a maximum in the ground just south of No. 4 mine, and that there is a noticeable improvement in the quality of the coal also; that from the latter point the seam begins to split up into a group of smaller seams, and that, with

this latter change, the quality of the coal slowly deteriorates; that the splitting up of the seam is caused by the thickening of two well defined bands (Nos. 2 and 4) and by a third band of clay that only makes its appearance near the southern limits of the field, and that all of these marked changes have taken place in the comparatively short distance of about five miles.

Although it is seldom that these changes occur to such an extent and so rapidly in any one seam, yet the Almy mines are very instructive in that they offer types of changes very common in western coal measures. It is not the exception but the rule with our western seams to show rapid change in thickness and quality, and the study of a well developed giant seam, such as this, will unquestionably convey much information that may prove beneficial to those developing coal lands in distant localities.

The Almy seam has now been opened and developed along most of the workable portion for a distance averaging 1,500 to 2,000 feet from the outcrop. The coal is said to be as good in the face of the slopes as it was near the surface. The seam produces fire damp and the floor is not the best for mining purposes. The question of the method of extracting the coal back of the present old workings has not yet been considered, as there still remains a large amount of reserve coal in No. 7, No. 6 (above the fault), No. 5, and elsewhere. The coal is chiefly used as locomotive fuel, but is also quite extensively sold by the Rocky Mountain company for domestic use.

The production of the Almy mines is given in the tables at the end of this chapter.

SECTION III.—THE ROCK SPRINGS MINES—GEOLOGICAL STRUCTURE OF THE ROCK SPRINGS UPLIFT.

The writer has made no detailed study of the general geology of the region around Rock Springs. The following brief, but able description is an extract from a chapter of the geology of the Green River Basin, by S. F. Emmons.*

"Cretaceous Uplift of Bitter Creek—This is the main pre-tertiary flexure in the basin country between the Rocky Mountains and the Wahsatch, and, as will be observed by reference to the map, is approximately on the same north and south line, as the Archaean body of Red Creek, and the complicated system of folds and dislocations in the Uinta range, along the lower canon of Green River. This fact points to the probable existence of a north and south submerged Archaean ridge, or continuation of Red Creek body, which has been the determining course of the flexures and dislocations produced by contraction in the overlying sedimentary beds along this line.

This uplift is an anticlinal, or rather quaquaversal fold, whose longer axis is approximately north and south; the beds involved in it having a steeper dip towards the west and south, while to the east and north they slope off so gently as to present no non-conformity of angle with the overlying Tertiaries. These dips are about 5 to 7 on the east, as shown along the railroad from Black Butte Station to Salt Wells, and 12 to 15 on the west side, as seen along Bitter Creek, from Salt Wells Valley to Rock Springs; while

*United States Geological Explorations of the Fortieth Parallel, Clarence King, Geologist in charge. Vol. II. Descriptive Geology by Arnold Hagen and S. F. Emmons, Washington 1887.

TABLE NO. 4

COAL MINING STATISTICS FOR THE YEARS 1894 AND 1895.

UINTA COUNTY.

Town	Railway hauling coal.	No. of mines worked.	Name of mine.	Operated by—	General Superintendent.	Local name of seam.	Thickness of coal worked (feet).	Output through—	Ventilated by—	Maximum capacity, 10 hours.	Proposed maximum capacity of mine.	Opened prior or subsequent to 1894.	PRODUCTION. 1894.	PRODUCTION. 1895.	REMARKS.
Red Canon	U. P. Railway	1	No. 3	U. M. C. & I. Co.	A. P. Bradbury, Red Canon	Big Seam	23 — 25	Slope	Fan	1,000		Prior	20,105	18,195	
"	"		No. 6	"	"	"	21 — 23	"	Nat. draught	700		Subsequent			
Almy	"	1	No. 4	U. P. Coal Dep't	Thos. Middleton, Rock Springs	"	28 — 30	"	Fan	1,000		Prior	155,226	166,030	Abandoned Nov., 1895.
"	"		No. 7	"	"	"	12 — 24	"	Fan	1,000	1,200	Subsequent			Opened Nov., 1895.

SWEETWATER COUNTY.

Rock Springs	U. P. Railway	4	Hopkins	Mark Hopkins' Co.	Mark Hopkins, Rock Springs	No. 7	7 — 7½	Drift	Term. furnace	800	800	Subsequent	Nothing	2,240	
"	"	4	No. 1	Rock Springs P. Co.	P. J. Quealey, Rock Springs	No. 1	7 — 11	Slope	Fan	400		Prior	67,400	72,800	Reopened 1895.
"	"	4	No. 2	"	"	No. 2	8 — 8½	Drift	Nat. draught	150	1,000	Subsequent	Nothing	1,260	Opened Nov., 1895.
"	"	4	Van Dyke	Hall & Cotton	Mr. Cotton, Rock Springs	Van Dyke	7	Slope	Furnace	700		Prior	30,200	32,400	Originally opened 1870
"	"	1	No. 1	U. P. Coal Dep't	Thos. Middleton, Rock Springs	No. 1	10 — 11½	Slope	Fan	1,100		Prior			
"	"	4	No. 3	"	"	No. 3	5 — 7½	"	"	800		"			
"	"	4	No. 4	"	"	No. 4	9 — 11	"	"	1,000		"	340,515	370,320	
"	"	4	No. 5	"	"	No. 5	6½ — 7½	Shaft and slope		900					
"	"	4	No. 7	"	"	No. 7	4½	Drift	Furnace	700		Subsequent			Opened 1894.
"	"	4	No. 8	"	"	No. 8	6½	Shaft	To be prepared		800	"			Opened 1895.

CARBON COUNTY.

Carbon	U. P. Railway	1	No. 4	U. P. Coal Dep't	Thos. Middleton, Rock Springs	Carbon	5 — 8	Slope	Fan	700		Prior	347,754	170,000	
"	"	1	No. 5	"	"	"	5 — 8	"	Furnace	700		"			
Dana	"	1	No. 1	"	"	Dana	7 — 8	"	Fan	800		Subsequent			
Hanna	"	2	No. 1	"	"	No. 1	14	"	"	500	1,000	"			
"	"	2	No. 2	"	"	No. 2	14	"	"	500	1,000	"			

CONVERSE COUNTY.

Glen Rock	N. W. System	1	Deer Creek	Deer Creek Coal Co.	Mr. Allan, Glen Rock		5 — 8	Slope	Nat. draught	100		Prior	13,000	24,000	Opened 1887.
Inez	"	1	Box Elder	Fetterman Coal Co.	A. D. Chamberlain, Inez		6	"	"	100		Subsequent	18,283	17,665	

CROOK COUNTY.

Cambria	Burlington System	1	Jumbo	Kilpatrick Bros. & Collins	Jos. Hemingway, Cambria		7 — 8	Drift	Waste heat	100	2,000	Subsequent		2,000	Opened 1893.
"	"	1	Antelope	"	"		7 — 8	"	"	200	2,000	"		2,000	Opened 1895.
*Estimated												Estimated output of mines not shipping by rail		10,000	10,000
												Total		1,407,576	1,412,956

in the canon of Little Bitter Creek, to the south of Quacking Asp Mountain, are outcrops of the sandstones of the Laramie series which dip at angles of 25 to 35 to the southwest.

The open valley of Salt Wells in the center of this fold is covered for the most part by clayey Quaternary soil, and presents no outcrops, with the exception of a little rounded hill of argillaceous beds in the middle of the valley, from which, however, no fossils were obtained. From the lithological character of the few beds seen, and their position relative to the surrounding and overlying sandstones, it is evident that the upper beds of the Colorado series have here been denuded to a probable depth of 500 to 1,000 feet. The existence and relative position of these beds have been deduced rather from the angle of the overlying Fox Hill beds, which form the bluffs surrounding the valley, than from actual observation. Towards Quacking Asp Mountain, at the southern end of the valley, the anticlinal fold seems to close together with sharper dips, while at the north its beds pass under the Tertiaries at low angles, forming low circling edges facing inwards.

Capping the bluffs, which face the valley on its western edge, about six miles east of Rock Springs, is a bed of compact, close-grained sandstone, almost approaching the nature of quartzite, in which were found casts of fragments of *Ammonites*, and some small bivalves, possibly *Cardium* and *Inoceramus*. Although too fragmentary for specific determination, these remains were sufficient to identify the beds as belonging to the Fox Hill group. They have been therefore considered as marking approximately the dividing line between this and the Laramie group. They are enclosed, both below and above, in coarse gray sandstone, of no very distinctive lithological character. * * The beds dip here about 13 to the westward. To the south these sandstone ridges disappear under the horizontal Tertiary beds, which form the bench-like spurs to the west and south of Quacking Asp Mountain.

This mountain is a sharp, narrow ridge, made up of thinly bedded brown sandstones, which strike to the northeast and dip to the southeast. They are, in general, much harder and more compact than the sandstones of the Fox Hill group; which is probably due to some local metamorphism. They may be considered to represent the opposite side of the fold from the rocks of the ridge just mentioned above, but their direct connection with these beds was masked by the Tertiary benches. In the deep ravines of South Bitter Creek, however, almost continuous exposures of the loose white sand rocks of the Laramie series can be traced, which, with a dip of 14 to the westward and a strike to the east of north, in the lower part of the valley near the railroad, gradually curve in strike to the westward as one goes south, and steeper in dip, till in the narrow ravines near the head of the Creek, to the south of Quacking Asp Mountain, they are seen to dip 35 to the south with a strike to the northwest. It may therefore be supposed that the beds which form Quacking Asp Mountain, bend round in the same way under the Tertiaries.

On the eastern side of the valley, the lower sand rocks, exposed in the parallel lines of the bluff which enclose it, have been referred to the Fox Hill group, though the dividing line between this and the Laramie series is not easy to determine. Corresponding beds to those containing fragments of *Ammonites*, on the west of the valley, were found in the bluffs, about six miles northeast of Salt Wells Station. In lithological character, the distinction between the Fox Hill and the Laramie groups is not very marked. In general, the sandstones of the former are more compact, frequently thinly bedded, and showing a tendency to split up into flags, or thin slabs. They are characterized by the presence of marine fossils, *Ammonites*, *Baculites* and *Inoceramus*, and by the rareness of coal seams. In the Laramie, on the other hand, the marine fossils are mostly confined to the genus *Ostrea*. The sandstones are less compact and frequently impure, and stained by oxide of iron, which also occurs in concretionary deposits of sufficient extent at times to constitute an ore bed. They are characterized by a greater development of clayey beds, and by the great number of coal seams, of which as many as fifteen to twenty can frequently be observed in a section of less than 1,000 feet, and by the presence of great quantities of leaves and plant remains, especially in the upper portion of the series. The thickness given in the section for these two groups is about 3,000 feet for the Fox Hill, and 6,000 feet for the Laramie series. This thickness is deduced from the angle and width of the outcrop of the beds, and may therefore be placed at rather a high figure, inasmuch as it is probable that there has been some faulting, which would make this width greater than it should be normally. On the other hand, owing to the unconformity of the Tertiaries, it is impossible to know how near the highest beds exposed may be to the top of the Laramie series.

In the region between Black Butte and Quacking Asp Mountain, and also that to the west of the Leucite Hills, along the northern edge of the map, there is a gap in our

observations, and the outlines between the formation in these regions are based on rather observations of the apparent line of the outcrop; a mode of geological study which gives a very fair approximation of the truth in a country so bare of vegetation, and where the topographical features are so dependent upon geological structure as this. On the eastern side of the anticlinal, the beds of the Laramie group were observed principally in the region bordering the railroad from Black Butte Station to the Salt Wells Valley. This region consists of low, broken ridges of loose, friable sandstone, having a general north and south trend, and eastern dip of from 5 to 7 within it are found local dips as high as 18, which point to a certain amount of dislocation in the beds.

Owing to the generally low angle of inclination of the Laramie beds on this side of the anticlinal, direct evidence of their non-conformity with the overlying Tertiaries is difficult to obtain. Only two instances were observed, one in the bluffs to the east of the railroad, a little north of Black Butte Station, where there is distinct non-conformity between the beds at the base, and those which form the summit of the bluff, and again to the north of Point of Rocks Station, where the discrepancy of angle is only 2. The finding of fossils of distinctly fresh water types, in the vicinity of marine and brakish-water forms, may be explained by a non-conformity of erosion, where fresh water Tertiary beds of similar lithological character, had been deposited in valleys eroded out of the rocks of the Laramie group.

From Black Butte Station to Point of Rocks, the course of Bitter Creek winds through low sandstone ridges, following in general their trend. The rocks exposed are grayish-white and rusty-reddish sandstones, with intercalated beds of sandy clays and carbonaceous shales, the latter frequently opening out into well defined coal seams. The coal seams are not, however, continuous for any great distance, and do not, therefore, afford a means of tracing a correspondence of geological horizon. In many cases, the carbonaceous shales have, in former times, become ignited, and have burned out, leaving a rusty-red ash material in their place. The highest coal seams observed are those in the bluffs to the east of Black Butte Station and at Hallville, of which the former has a thickness of about 4.5 feet, and the latter 6 feet; in either case capped by a well-defined clay seam. In this clay, above the Hallville coal, were found numerous remains of fresh water fossils, among which were recognized *Corbicula fracta*, *Corbicula crassatelliformis* and *Unio* (sp ?). Similar, and in some cases, identical forms have been found by Prof. Meek in the beds overlying the coal at Black Butte Station. These, facts, taken together with the evidences of displacement observed at the Hallville coal mine, render it probable that the two belong to the same horizon, and that the overlying beds and possibly even the coal seam itself, if it be true, as reported, that coal has been discovered in the Vermillion Creek beds to the west of Rock Springs, may belong to the overlying Tertiary. The discovery by Prof. Cope, since the completion of our field work, of the remains of a saurian, in the neighborhood of Black Butte Station, proves the existence at the surface of well-defined cretaceous strata as far east as this point. Great quantities of leaf impressions and plant remains are found also in the sandstones near Black Butte Station, which, however, on account of their wide range and the want of direct correspondence in the flora of this region with that of the Atlantic coast, or of Europe, are of little value in the determination of the geological horizon.

To the west of Black Butte Station, the sandstone ridges, which, near the railroad, are degraded and much obscured by clayey and shaley debris, becomes gradually higher and more prominent. The peak of Black Butte, which is a prominent landmark in this region, attaining a height of over 8,000 feet, is formed of one of these more massive sandstone beds, whose horizon corresponds with those exposed in the country to the west of Point of Rocks Station. It has apparently been preserved from erosion by local metamorphism. The summit consists of a huge homogeneous block of sandstone, about 50 feet cube, whose upper surface is thoroughly vitrified, while the lower part still preserves the soft friable nature of the sandstones of this region; this metamorphism only penetrates a few feet within the rock, and presents a regular graduation from a glassy state, almost like a slag, to that of a loose granular sandstone, which crumbles between the fingers.

Along Bitter Creek, to the west of Point of Rocks Station, and in the dry stream-bed to the eastward, a more continuous section is afforded at right angles to the strike. Throughout this section there is little variety in the general lithological character of the beds. The exposures are principally sandstones, gray and brown, more or less stained by iron oxide. But as shown in the section made by the artesian boring at the railroad station, beds of clay and shale form no inconsiderably portion of the formation, though, being much more easily eroded, they are not seen on the surface. Some of the sandstones give slight effervescence with acid, but the amount of calcareous material is com-

paratively unimportant, and due probably to the percolation of water charged with carbonate of lime. Throughout the whole section are found seams of coal, which, however, have been more explored in the upper part of the section in the neighborhood of the railroad station. The coal beds carry a good deal of iron pyrites, to the decomposition of which is probably due the fact that almost all the springs in the vicinity are strongly impregnated with sulphur. There is a beautiful sulphur spring, whose waters are very cold and clear, at the point of the bluffs a short distance to the east of the railroad station, and in the ravine northwest of that station there is a chalybeate spring which deposits salts of iron. To the northward, toward the Leucite Hills, the surface of the bluffs is plentifully covered by fragments of brown hemitite of concretionary structure, which have been weathered out from the sandstone, and whose quantity renders it probable that careful search might reveal workable beds of iron ore in this region. The fossils found along this section of the Laramie beds are principally confined to varieties of *Ostrea*, among which have been determined,

Ostrea glabra.
Ostrea Wyomingensis.
Anomia gryphorhynchus.
Cyrena cytheriformis.

Specimens of *Ostrea* were obtained as far east as the line of bluffs bordering the dry water course to the east of the Leucite Hills, which form the limit of our explorations in that direction. In the bluffs to the south of the sulphur spring, which have a height of about 350 feet, are exposed some seven seams of coal, from one foot to seven feet in thickness, interbedded with beds of rusty sandstone from a few inches to twenty feet thick, and seams of sandy and clayey shales. At the base is a massive white sandstone fifty feet in thickness, overlaid by brown, sandy shales, containing a seam of coal three feet thick, which dips 7 to the eastward. The beds at the top have a dip of less than 5, a difference of angle too slight to enable one to determine the exact point of non-conformity A similar series of beds, in which the same condition of angle exists, is found in the bluffs to the north of Point of Rocks Station.

To the west of Point of Rocks the sandstones are generally more heavily bedded, and contain a smaller proportion of shaley material, passing by immense gradations into the beds of the Fox Hill group. In the sandstones of this latter group is found a thin bed of green compact argillaceous rock, very close-grained, and resembling similar beds at this horizon on the east side of the Platte at Fort Steele and in the Oyster Ridge. It has the appearance of an indurated clay, but contains some little calcareous matter. The strike of the ridges along the line of the railroad is about 5 to the west of north, but to the northward they curve rapidly to the west, and form a semi-circular line of bluffs, which encloses the Valley of Salt Wells on the north. Northwest of Point of Rocks is a higher plateau-like region, which has been preserved from erosion by flows of volcanic rock, which will be noticed further on. In the outcrops of sandstones seen a few miles before reaching Salt Wells Station, and in the low hills to the south and east of that point, the beds have an almost horizonal position, with a slight dip to the eastward. They are largely clays, with some thin intercalated beds of sandstones.

The axis of the anticlinal is probably still to the westward of these bluffs, and we may estimate about 1,000 feet of clayey beds exposed beneath the sandstones, which form the bluff line just to the east and south of Salt Wells Station. Owing to the want of outcrops, the actual point of change of dip in the beds cannot be observed; but at the entrance of the canon of Bitter Creek, to the west of the valley of Salt Wells the beds of massive sandstone dip 12 to the westward. In the section exposed from here to Rock Springs Station are numerous beds of coal, whose correspondence with the strata on the eastern side of the fold cannot be determined with any definiteness; but it is probable that the seams here exposed have a lower horizon than any which have been worked at Point of Rocks or at Black Butte. The lowest seam observed is that of the Van Dyke mine, about two miles west of the Salt Wells Valley, which has a thickness of four feet of excellent coal, and is overlaid by a red, iron-stained sandstone, containing thin beds of limonite. This seam is considered to be near the base of the Laramie group.

From this point to Rock Springs Station the croppings of some ten different coal seams were noticed, but many must have escaped observation since, in an artesian boring made at Rock Springs Station, no less than seventeen coal seams were crossed in a depth of 700 feet. The principal bed, which has been extensively mined by the Wyoming Coal Company about two miles east of Rock Springs Station, has a thickness of nine to eleven feet, and stands at an angle of fifteen. The strike of the ridges at this point is about 30 to the east of north. The fossils found in these sandstones are few,

and in general similar species of *Ostrea* and *Corbula* to those found on the east side of the fold. Owing to their steeper angle of dip, there is less liability of confounding them with the overlying Tertiaries, and no unmistakable fresh water types have been found in them. The springs in this neighborhood, as to the eastward, are largely charged with sulphur.

To the west of Rock Springs, the sandstone ridges become lower and more infrequent, and are gradually concealed beneath surface debris. The highest outcrop observed was that of a yellow, slightly calcareous sandstone. From these ridges, to the base of the cliffs, formed by the beds of the Green River series, to the north of the railroad, the surface is covered by a light reddish clayey soil, resulting from the decomposition of the upper beds of the Vermillion Creek series, which rest unconformably upon the Laramie beds. The unconformity is most distinctly marked, however, in the beds of the Green River series, which dip only 4 to the west, as seen in the bluffs north of Bitter Creek, a short distance west of the sandstone ridges of the Laramie group. To the north of the railroad our observations extended but a little distance. To the south the sandstone ridges of the Laramie group curve in, strike to the eastward, being partially concealed beneath the horizontal Tertiaries, which cover the flanks of Quacking Asp Mountains, and at the head of South Bitter Creek, as already observed, are found with a strike of north 30 west.

The study of the rocks of this region, while it only serves to confirm the observations on the beds of the Laramie group at other points, which show that they were deposited conformably over the older cretaceous formations, and prior to the great period of plication and uplift in which the Rocky Mountains and the Uinta and Wahsatch Ranges received their main elevation, and that they may therefore be properly regarded as of cretaceous age, while the mingling of the marine and brackish water forms in their fauna indicate local shallowings in the seas in which they were deposited, where even fresh water shells, brought down by rivers, may have been mingled with the remains of animals which actually lived in their waters, shows also that similar conditions of life existed during the early part of the Eocene tertiary period, which immediately succeeded it, and that when the deposits of this period were laid in approximate or actual conformity with the underlying beds, and have since been disturbed in regions of preexisting movement, it is not always possible at the present day to draw a line of definite demarcation between the two formations."

THE LARAMIE ROCKS AT ROCK SPRINGS.

As shown in the foregoing extract the Rock Springs mines are situated upon the western side of the Bitter creek quaquaversal uplift and as a consequence the general dip of the coal seams is almost west and the average strike north and south. Owing to the topography of the surface about the mines the line of outcrop does not always approximately correspond to the strike. The town is in Bitter Creek valley. Following the outcrop of any ledge or seam toward the north it will be found to take a general northeasterly course until the summit of a long, high ridge, between Kilpatrick creek and Baxter basin, is reached, and then to follow that ridge with a general course of almost due north until the strike begins to change to the eastward. To the south from Rock Springs the rise is not so great, and several faults and with an upthrow to the south causes the general line of outcrop to be nearly south until the valley of Lob Canyon is reached, when the steep sides of the latter cause it to make a bold swing to the west across the canyon and ascend the hills of the opposite side in a southeasterly direction. All these courses of outcrop refer to general courses through distances of several miles. When cut by deep gulches the croppings are all locally swung down towards the westward.

Strata exposed in the bluffs below the Van Dyke mine con-

sist of soft argillaceous rocks with numerous hard strata of reddish-yellow sandstone, rather thinly bedded, and some impure seams of carbonaceous matter. At least one outcrop of massive gray sandstone is visible some distance below the seam. The formation here has a dip to the west not exceeding 6°. From the Van Dyke seam west, for almost three miles, the rocks consist of similar argillaceous strata and sandstone of no great thickness, together with very prominent strata of "ashen gray" sandstones of considerable thickness. Usually the latter rocks are lighter gray towards the top and darker, often with a yellowish cast, lower down. They are peculiar in the fact that each of them underlies one of the workable seams of coal above the Van Dyke. On this westerly course the dip of the strata has increased to over 12°. West of the seams of coal that have been extensively opened (old No. 6 seam) the gray massive sandstones become thinner and less frequent, and if present at all they are not prominent. The other strata retain about the character already noted.

THE COAL SEAMS.

The number of seams of coal in the Laramie at Rock Springs is unknown. That there are a great many is certain. That the number will vary according to the point of section is also well settled. Mines have been opened upon the six lowest known seams that are large enough to work, as exposed in the immediate vicinity of the town. Besides these there are other large seams occurring higher up in the formation whose existence is only known through shallow prospect tunnels or inferred from the croppings. Besides the larger seams there are an indefinite number of smaller ones varying from three feet to a fraction of an inch in thickness. As will appear later it by no means follows that because a seam is too small to work at one point it remains so. The reverse is equally true, some of the larger seams becoming, locally at least, too small to work; but it is thought better to mention these facts and describe their occurrence, together with the notation of occurrences of slate and rock in the seams, in the more detailed description to be given further along in this report.

Owing to the general practice of naming mines according to the sequence in which they were opened by the company, and subsequently naming each seam after some prominent mine upon it, the designations of Rock Spring seams, though in numerals, gives no information as to the order in which they occur. I am indebted to Mr. George L. Black for the measurements given in the following statement. This table shows only the seams upon which mines have been opened and the distances given between seams are only approximate.

TABLE I.

Local name of seam.	Order from bottom.	Thickness (feet).	Vertical distance to seam above.	Names of mines located upon the seam.	Condition.
Van Dyke...	1	4	200	Van Dyke Mine.....	Producing.
No. 7.....	2	4½ to 7½	(4)	Union Pacific No. 7.....	Producing.
			(3)	Union Pacific No. 8.....	Producing.
			300 (1)	Mark Hopkins Mining Company.....	Producing.
			(2)	Rock Springs Mining Company No. 2	Producing.
No. 1.....	3	9 to 11	(3)	Union Pacific No. 1.....	Producing.
			(4)	Union Pacific No. 4.....	Producing.
			225 (1)	Union Pacific Old No. 2...	Abandoned.
			(2)	Rock Springs Mining Company No. 1	Producing.
No. 3.....	4	4½ to 7	(1)	Union Pacific New No. 5...	Producing.
			220 (2)	Union Pacific No. 3.....	Producing.
No. 5.....	5	7	400 to 700	Union Pacific Old No. 5...	Abandoned.
No. 6.....	6	7½	.....	Union Pacific No. 6.....	Abandoned.

All of the Rock Springs mines are located near the junction of townships 18 and 19, ranges 104 and 105. The Mark Hopkins mine is the most southerly opened; the Union Pacific No. 7 mine the most northerly. East and west lines drawn through the extreme opposite workings of these two mines would be scarcely five miles apart. All the workings of the other mines would lie between these two lines in a belt not much more than three miles wide.

THE VAN DYKE SEAM.

The Van Dyke is the only mine upon this seam. As far as the writer knows the croppings have never been traced definitely beyond the section upon which the mine is located (Sec. 30, Tp. 19, R. 105). The seam as opened averages four feet in thickness. It shows little variation, being seldom less than 3 feet 8 inches nor more than 4 feet 2 inches. The roof of the seam is hard fire clay, which stands well so long as there is a current of dry air upon it. Where the exposed surface has no dry air to carry away the exuding moisture it scales down in thick heavy slabs. The floor of the seam is likewise a fire clay which becomes somewhat arenaceous a few feet below. Solid gray sandstone does not appear for the first ten feet below the coal.

The dip of the seam where measured was from 3.5° to 5° nearly due west. The coal is perfectly clean, showing no slate whatever. An average sample of this coal, taken from the north side of the plane from the main output tunnel, gave the following analysis:

Water	8.86
Gas	39.15
Fixed carbon	49.13
Ash	2.86

Sample taken Dec. 7th, 1889. Analysis made Dec. 11th, 1889.

Between the Van Dyke mine and the No. 7 seam upon an east and west line there does not appear to be any seams of coal large enough to work, but there is a group of thin seams lying nearer the former seam than the latter which increases in size towards the north. About one mile north of the Van Dyke main tunnel there are openings upon three of these seams, two of them showing but two or three feet of coal, the third over four feet (4 feet 2 inches) of very clean and bright looking coal. Continuing still further north to Sec. 8, Tp. 19, R. 104, on the western slope of Baxter basin, the seams are found to have further widened so that two of them are at least six feet thick, a third about four feet and several others smaller. It is said that the two larger ones have been opened about three-fourths of a mile further north and are there nearly seven feet thick. The two larger seams are about fifty feet apart and at least 150 to 200 feet lower than No. 7 seam, which outcrops at the upper edge of the bluff forming the side of the basin.

No. 1 of the following analyses represents an average sample of the upper of these two seams, No. 2 a sample of the lower:

	1.	2.
Water	10.59	11.04
Gas	38.28	39.86
Fixed carbon	49.48	47.69
Ash	1.65	1.41

Samples taken Dec. 7th, 1889. Samples analyzed Dec. 11th, 1889.

THE NO. 7 SEAM.

I regard the capacity of this seam for producing coal as greater than any other seam at Rock Springs. I refer to the district, let us say, four miles to the south and the same distance to the northeast of the town. It will be seen by the description given of the mines upon it that the seam shows considerable variation in thickness, and is never over 8 feet in the district indicated; yet withal it is remarkable in its maintainance of a workable thickness and clean coal, which more than counterbalances the lack of size.

The Mark Hopkins mine is the most southerly large opening upon the seam. It is situated in Lob Canyon and the main tunnel begins near the center of sec. 14, tp. 18, r. 105. The seam is from 7 to 7.5 feet thick and is perfectly clean, with neither bone nor parting. It has here an average dip of 7° to 8° n., 85° w. There is a stratum of impure clay only a few inches thick immediately below the coal, and then there is a firm, massive gray sandstone. The stratum is astonishingly uniform in appearance and persistent in its occurrence, and the seam may be traced for miles by following its outcrop. Above the coal there is 10 feet of clay shale and then a reddish sandstone that is also very persistent.

There is a system of characteristic joints or slips everywhere present in the Rock Springs coal seams, from the Van Dyke upward. They are very prominent in the Hopkins mine, where they, as is usually the case, part the coal from roof to floor, every foot or two. These slips always run a little south of the dip (5° to 20°). They are generally inclined towards the south. The faces present every peculiarity of a fault and frequently there is an actual displacement along them of from 1 to 4 inches. When there is such a displacement the fissure usually passes into the roof of the seam. Where no displacement is observed this is not the case.

About a mile northeast of the Hopkins tunnel there are a series of shallow cuts upon No. 7 seam that show about 7 feet of clear coal. About 2 feet from the roof there are two thin seams of clay about 2.5 inches apart, each of which is from a quarter to half an inch wide. This double clay parting is uncommon, but a single parting of this nature is very persistent throughout the seam, the Hopkins mine being the only locality that does not show it. The distance from the roof is about 2 feet, no matter what the thickness of the seam. Another peculiarity is the presence of a thin band consisting of alternate streaks of clayey matter and coal, which lies on top of the coal. This scale is from 2 to 5 inches in thickness. When exposed to the air it soon scales down in flakes. The displacement along the slips is well shown in one of the cuts referred to above. The two clay streaks show four small faults in a space of 20 inches. These consist of:

1.	Downthrow to south.....	2 inches
2.	" "	4 inches
3.	Upthrow "	1 inch
4.	Downthrow "	3.5 inches

The inclination of the faulting planes varies from 40° to 65° with the horizon.

Following the croppings of No. 7 seam on towards the town the gray sandstone floor is temporarily very prominent and outcrops beyond the coal as a bare platform. About 1.5 miles from

the Hopkins mine it is suddenly broken by a fault of about 100 feet displacement, with a downthrow to the north. This fault appears to have a general course of s. 60° w., and passes in this direction across the southwest quarter of sec. 2, tp. 18, r. 105. Along the line of outcrop and not over 1,200 feet to the north there is another fault, with a displacement in the same direction, probably amounting to 150 feet. This fault has a direction of about s. 75° w., and consequently diverges from the former toward the west. It also passes into section 2. Another peculiar feature of this fault is that it is soon lost sight of in the flat to the west, but following its general course, near the center of section 2, a fault is observed just north of the Klegg opening on No. 1 seam, with an upthrow north of no great amount. Continuing on the same course the fault is found to have a displacement of nearly 100 feet, with an upthrow to the north, as plainly shown on the croppings of No. 3 seam. The Rock Springs Coal Company's No. 1 mine, lying immediately north of this fault, shows no other serious displacement in that direction, and the continuous outcrop of the sandstone floor of No. 3, for some distance south, indicates no disturbance southward. Consequently it appears either that the displacement shown on the No. 7 cropping makes a great change in its general course, or that it rapidly decreases toward the west to a point where there is no displacement and then increases to a throw in the opposite direction. An apparent greater dip of the strata upon the south side of this fault might, perhaps, help to explain the phenomenon.

Between the two faults just described there is an opening upon No. 7 seam which shows it to contain six feet of coal of excellent quality. The clay parting, two feet from the roof, is about a quarter of an inch in thickness.

The next openings upon No. 7 seam are on sec. 35, tp. 19, r. 105. This property has been recently purchased by the Rock Springs Coal Company, which is here opening a new mine (No. 2). The seam, as exposed in the two strike tunnels now driving, shows 5 feet of clear coal, only broken by the usual parting (see Fig. 2, Plate II). The dip is from 7° to 9°, but the strike has swung a little to the west of north (n. 10° to 20° e.) Roof and floor are of the usual character. Owing to deep gulches on this section the outcrop is irregular and has never been accurately located. After crossing the main gulch near the center of the section it passes up a lateral ravine and returning swings in a bold curve across a high hill into the valley of Bitter Creek, upon the north side of which the Union Pacific No. 7 mine is located. The seam appears to have reached its minimum thickness of 4.5 feet in this mine. The coal as a rule is very clean and pure. The normal clay parting is present. The dip is not more than 7° and the strike has changed to about n. 65° e. A section of the seam, as shown in this mine, is represented in Fig. 3, Plate II. Near the eastern limit of the mine the coal varies

from its usual excellent character. The streak of dirty coal and clay already referred to seems to widen and encroach upon the upper portion of the coal. Other bands of carbonaceous clay appear lower down but above the parting, and the entire upper 20 inches becomes worthless, in places leaving less than 3 feet of coal for mining. This belt of poor coal does not appear to be very extensive, however, and is apparently confined to a narrow belt running in a northerly direction.

Union Pacific No. 8 mine, now being developed, is opened through a shaft about west of the No. 7 main tunnel. The coal appears of excellent quality in the workings of this mine and the seam is about 4 feet 8 inches thick.

These two mines, and practically they are only one, for No. 8 is made to take out all the coal between it and the No. 7 strike tunnel with which it connects, are the most northerly upon the No. 7 seam. The Hopkins mine has but recently sufficiently developed to begin regular shipments. The Rock Springs Coal Company No. 2 mine has not yet a room started. In the aggregate the four mines have certainly not produced over 300,000 tons of coal. It will be seen, therefore, that the five mines from which there has been coal mined for the market have made but a comparatively insignificant inroad upon the coal which the seam contains.

North of No. 7 mine there are no extensive workings, but several prospect tunnels have been excavated upon the seam. Thus near the northeast quarter of Sec. 20, Tp. 19, R. 104, a tunnel 175 feet in length shows the seam to contain about 8 feet of coal (figure 4, plate II). A more extended section would give:

1.	Hard rusty sandstone.....		
2.	Light shales with silliceous band	9 ft.	(?)
3.	Dark shale clays.....	2 ft.	
4.	Coal.....	2 ft. 4	in.
5.	Clay parting.....	.33	in.
6.	Coal.....	3 ft. 1.5	in.
7.	Carbonaceous shale.....	5	in.
8.	Coal.....	2 ft.	
9.	Carbonaceous clay.....	6	in. (?)
10.	Massive gray sandstone.....		

Coal exposed is clear and bright and appears in every respect equal to that mined further south. Another tunnel upon the same seam starts near the top of the hills facing Baxter basin, in the southeast quarter of section 8, of the same township. Though the tunnel is over 200 feet in length it attains no great depth beneath the surface and the coal still shows the softening due to surface action in some of the streaks between the slips. The seam here contains 7 feet 6 six inches of coal. The clay parting is about 2 feet from the top. There is no carbonaceous

shale near the bottom, as in the seam as exposed on Sec. 20. The dip is about 10° and the strike has swung back to almost due north.

I have traced the croppings of this seam but a few hundred yards north of this point, but have been to a point some five miles north (Sec. 20, Tp. 20, R. 104) where the Rock Springs company have several prospects. On the particular section referred to there is a seam showing 9 feet 8 inches of perfectly clean coal without even a parting of any kind. A tunnel some 40 feet in length shows bright looking coal, but still with signs of surface action. It appears very probable that this is No. 7 seam.

From the description given above it will be seen that Rock Springs No. 7 seam may be traced surely for a distance of nearly six miles and almost surely for a distance of nearly eleven miles. It is not known to extend further because no attempt has been made to trace it. While the seam shows great variation in size in this eleven miles, being but 4.5 at the thinnest place known and nearly 10 feet at the thickest, yet, as far as developed, it is large enough to work with profit on account of the excellent quality of the coal and the remarkable freeness of the seam from bands of slate. The amount of work done upon the seam is, comparatively, so slight that an estimate of the amount of coal it is capable of producing is not justifiable, but it is certain that the quantity is very great. The following analyses of samples of coal from various openings on this seam have been made by the writer at various times.

	Water.	Gas.	Fixed carbon.	Ash.
Hopkins mine.....	6.76	38.74	53.27	1.23
" Tunnel on Sec. 1..	6.65	39.86	49.28	4.21
Rock Springs Coal Co. No. 2,	7.08	38.54	52.63	1.75
Union Pacific No. 7.....	9.22	38.78	49.52	2.48
Sec. 20, tp. 19, r. 104.....	7.57	37.25	51.88	3.30
Sec. 8, tp. 19, r. 104.....	10.98	37.35	48.36	3.31
Sec. 20, tp. 20, r. 104.....	11.88	39.29	47.51	1.32

THE NO. 1 SEAM.

This seam, which lies about 300 feet above the one last described, is the third worked in the order from the bottom. Although most of the coal hitherto mined at Rock Springs has been taken from No. 1 seam, the mines upon it are closer together and less prospecting has been prosecuted along its outcrop, so that it is not as well understood as the No. 7 seam. It is apparent, however, that while the coal attains a maximum thickness far greater than shown in No. 7 seam, it is by no means so regular, and is apparently capable of giving neither the area nor the quantity of coal that the latter seam may furnish. The ground upon which the mines of No. 1 seam are located appears to be more broken by faults. The most southerly mine opened

upon this seam is the Rock Springs Coal Company's No. 1 mine. Next north is the now abandoned Union Pacific No. 2 mine, then the Union Pacific Nos. 1 and 4 mines, the latter being the most northerly upon it.

South of the first named mine there are several openings, none of which were visited by the writer. The Klegg tunnel, southwest of the Blair mine, is said to show 10 feet of coal. Another opening upon the east side of Lob Canyon is said to show 9 feet of coal and one to the west about 4 feet 6 inches.

The Rock Springs Coal Company's No. 1 mine is situated upon sec. 2, tp. 18, r. 105. The fault upon the south side of the mine has been described. The seam is about 11 feet thick and in the upper working perfectly clean. Bands of slate are encountered in the southwestern workings, but appear near the bottom of the seam and leave 7 feet of coal above it. The mine is not yet sufficiently developed to show the form of this boney area. Union Pacific No. 2 mine, now abandoned, also showed boney coal upon it in the western and southwestern portions of the workings. It seams probable that there is an area or zone containing bands of slate in this portion of the seam and that both of these mines have encountered it, but the writer is not sufficiently familiar with the ground to deseribe its nature.

No. 2 is separated from No. 1 mine by a fault having a general southwesterly direction and a maximum throw of about 70 feet down to the northeast. No. 1 mine is the oldest continuously worked and largest mine at Rock Springs. Its main slope is nearly 4,000 feet in length and the mine is opened by entries upon the strike to a maximum width of about 2 miles. In part it is naturally bounded upon the east and southwest by two faults, each with a maximum displacement of between 60 and 70 feet and each with a downthrow towards the mine. These two faults probably intersect a short distance to the southeast of the mouth of the main slope. The one to the southwest separates the mine from old No. 2, the other separates it from No. 4. The latter has been struck at several points, but the displacement has only been determined at one place, where it is 65 feet.

Figs. 5 and 6, Plate II, represents two typical sections of the seam as exposed in this mine. Fig. 5 represents the seam as exposed in the workings upon the north side of the main slope and in the north half of those on the south side. Fig. 6 represents the seam as shown in the south half of the workings south of the slope. There is a gradual transformation from the homogeneous seam of coal to the seam banded with slate, as shown in the latter section.*

A peculiarity frequently developed in the workings of No. 1 mine, but also common to the other mines upon the same seam,

* I am indebted to Mr. George L. Black, of Rock Springs, for the measurements from which these sections are constructed. Mr. Black also furnished me with data for draughting Figs. 7, 8 and 9 of the same plate.

is the so-called "rock-slips" or "horse-backs." These are long slim wedges of white sandstone which protrude usually from the floor of the seam into the coal. They have commonly a polished surface and natural natural parting from the coal upon one side and a rough surface to which the coal adheres upon the other. They extend sometimes only a few inches from the floor, sometimes almost or quite to the roof of the seam. They are very narrow, at most only a few feet at the base, and gradually wedge out until they disappear. Longitudinally they often extend for many yards. There is no rule for the direction in which they run, nor the frequency of their occurrence. The coal is of the normal quality, even in direct contact with the pure sandstone.

At a point nearly 3,500 feet from the mouth of the main slope a fault was encountered having an upthrow to the west of about 70 feet. Its general direction is northeast by north. The same fault was struck in the main slope of No. 5 mine, but had there a displacement of only 17 feet, while it seems to have played out further to the northeast. In other words, the displacement of this fault decreases more than 50 feet in less than 1,000 feet horizontal measurement. The seam contains 10 feet of clean coal west of this fault. The slope, which has an average inclination of from 10° to 12°, has been gradually flattened to half pitch and will be so continued until the coal is again entered beyond the fault. This mine, which has lately been fitted with a double track slope and double hoisting plant, has long been by far the largest producer in Wyoming, and it bids fair to continue so for some years to come.

No. 4 mine lies to the northeast of No. 1. The slopes of the two mines are nearly a mile apart. The slope of No. 4 passes a little to the northeast of the true dip, which has here locally changed to about n. 65° w. Consequently the slopes of No. 1 and No. 4 mines diverge rapidly. Fig. 7, Plate II represents a typical section of the seam as shown in this mine. The upper band is very persistent, though only one or two inches thick. It is a yellowish, white fine grained argillaceous sandstone. The lower band is the ordinary highly carbonaceous shale or so-called slate. It is not so persistent. While it disappears in the southwesterly workings, it thickens towards the north-east. This feature is a peculiar one well worthy of description. The coal near the outcrop is burnt out, especially towards the northeast. Below the burnt zone good coal is mined from both sides of the slope and shows only the yellow band about two and a half feet from the top. The lower levels northeast ultimately strike bands of slate, at first a great distance from the slope, then nearer to it until finally the slate shows in the face of the slope itself. The most prominent band of slate develops about three feet from the floor of the seam. Then other bands appear higher up, and the yellow band changes to carbonaceous shale and thickens. Finally the lower band changes into sandstone and

abruptly thicken by the upper surface raising until it replaces the entire upper portion of the seam. So rapidly is the change accomplished that the upper coal has entirely disappeared in a distance of only a few yards beyond the point where the sandstone first begins. One entry has been driven eighty yards beyond the first appearance of the sandstone. It shows three feet of coal on the bottom, continuing with great regularity, but with no sign of the upper portion of the seam, nor does a drill hole eight feet in length show other than pure sandstone. The face of the slope has now two feet of boney coal which has to be thrown out in mining, but the sandstone has not appeared. The entries to the south near the face of the slope soon pass out of this boney area and the seam assumes its normal condition. In this direction all developments, both in this mine and No. 1 tend to show that there is a very large area of excellent coal. In other words, although the mine has a large supply of reserve coal developed by entries and a much large undeveloped area, yet it is a one-sided mine below 2,500 feet from the surface. That is to say, all of the coal will have to come from the southwest side of the mine below that depth on the slope. None of the southwesterly workings of this mine have yet struck the fault that divides it from No. 1.

The No. 1 seam has not been definitely traced for any great distance northeast of No. 4 mine. Upon section 18 of the township east there is an opening upon a large seam that shows more slate than coal. Approximately it is in the right position and it may or may not be No. 1 seam. On sec. 31, tp. 20, r. 104, the Rock Springs Coal Company have an opening upon a great seam that shows 14 feet of perfectly clean coal. There is a fine exposure of the outcropping strata here and it seems probable that this is also the No. 1 seam. As on the prospect on section 20 of the same township, the strike of the coal is nearly due north.

The following are analyses of samples of coal from the No. 1 seam:

	Water.	Gas.	Fixed carbon.	Ash.
Rock Springs Coal Co. No. 1,	7.51	39.06	50.22	2.59
Union Pacific No. 4.....	9.05	40.00	48.87	2.08
Sec. 31, tp. 20, r. 104.....	12.69	40.55	45.92	1.34

THE NO. 3 SEAM.

No. 3 seam is 225 feet above No. 1 at No. 5 mine. To the south this distance evidently decreases. The only mines opened upon it are No. 5 and No. 3, both the property of the Union Pacific Company. The two mines are close together and are connected. Their main slopes are less than three-quarters of a mile apart.

No. 3 mine exposes from 6 feet 6 inches to 7 feet 6 inches of clean homogeneous coal and it remains such in the block of ground between No. 3 and No. 5 slopes. The coal rests upon a

band of fire clay over a foot thick, under which there is a seam of coal of about 14 inches. Over the large seam there is first a clay shale, then sandstone. Upon the north side of the slope is a band of slate that appears about 2 feet from the floor of the coal. It changes to sandstone further northeast and then only the coal above it is mined. Where the sandstone first appears the upper coal narrows in some places so much so that rooms are not turned off, but 200 feet beyond it widens and affords from 4 feet 6 inches to 5 feet 6 inches of good coal. As in No. 4, this zone is far from the slope at the surface and rapidly approaches it, so that it now has reached the face. In other words, the edge of the boney area runs about half way between the dip and the strike of the seam. The levels from near the face of the slope southwest show 7½ feet of clean coal. The entries to the north strike a fault that seems to correspond to the one between No. 1 and No. 4 mines. It has a displacement of from 8 to 12 feet only. Although its course is approximately north and south, it is very irregular. This indicates a playing out of the fault towards the north.

There is little to say further about No. 5 mine, which is worked through a shaft with a slope from where it strikes the seam, except that there seems to be another area to the southwest of that mine, in which a heavy band of slate appears near the center of the seam. This belt appears to run nearly at right angles to the stratum of sandstone near the bottom of the seam, as shown in the northerly workings of No. 3 mine.

The following is an analysis of a sample of coal from No. 5 mine:

Water	8.58
Gas	37.82
Fixed carbon	49.73
Ash	3.87

Old No. 5 mine, situated upon the seam above No. 3, and old No. 6 on the next known large seam above that, are both abandoned. The former because the seam showed too much slate, the latter because the coal was not good in quality. Little or nothing more can be said about them. A short prospect tunnel opens a 12 foot seam of coal still higher than No. 6 seam. An analysis of a lump of this coal gave:

Water	12.25
Gas	39.28
Fixed carbon	44.64
Ash	3.83

Such is a brief description of the seams of coal at Rock Springs as developed in the mines. There is so much coal that very little prospecting has been done except through actual mining. From the description it will be seen that beyond question large areas in all of the seams excepting No. 7 will never be

worked on account of a thinning of the seams or the appearance of too much slate, or both. But the fact remains that the quantity of coal the district immediately about the mines is capable of producing is enormous and that thus far it has scarcely been touched.

SECTION IV.—THE CARBON, DANA AND HANNA MINES.

The older stratified rocks outcrop about the base of Elk Mountain with a steep dip to the northwest, north and northeast. The cretaceous rocks outcrop with a waving strike, which, away from the mountain develops into two anticlinal folds, which radiate from it. One of these anticlinals has a northerly, the other a northwesterly course. The first forms a long, broad hill, called Simpson ridge. The latter is equally high and long, but much narrower. It has received no name. Between the two there is a broad synclinal basin of great extent. East of Simpson ridge there is a second synclinal forming the Carbon coal basin. Southwest of the other ridge a third synclinal contains the Pass Creek coal. The two ridges consist, near the top, at least, of sandstones, and argillaceous strata of the Fox Hill group, which dip at steep inclinations from their crests and disappear beneath the overlying Laramie strata.

The Carbon basin is elliptical in shape, the dip from the outcropping rocks being rudely towards the centre. The maximum width underlaid by the known coals seams is perhaps about six miles. The greatest length is ten or twelve. The width of the basin varies greatly on account of a series of faults which have a general trend of east and west, and as a rule upthrow to the south. Coal has been mined near the main line of the Union Pacific Railway, where it crosses the basin for about twenty yards. No 5, mine, now abandonded, is about three miles south of the mines worked. I am not familiar with the interesting features of this mine. It is said to be upon the same seam with the other mines and probably is. The coal dips toward the south and if it were continued with its average dip would be many hundred feet below the surface. But a fault of over 600 feet displacement has thrown the seam to the surface just north of the railway. Old mines now worked out followed the seam to a second fault, in this case a downthrow south of 133 feet. Again about 2,000 feet further south an upthrow to the south of from 175 to 190 feet bringing coal to the surface. Both of these faults have an irregular course, but an average trend somewhat west of north. No other very large faults are known, but there are many smaller ones both parallel with and transverse to the general course of the larger. But two mines are now worked at Carbon. No. 6 lies between the two faults and extends from northeast to the southwest side of the basin, which is here only about one mile wide. The slope has an inclination of from 5° to 35.37° w. from the surface, and gradually flattens to the synclinal axis and

then reverses into a plane having a slope of 3°, down which the coal from the west side is brought. Fig. 6, Plate III, shows a typical section of the seam as it is exposed in this mine. The coal has a maximum thickness of about 8 feet, a minimum of 5. The coal mined averages about 6 feet 10 inches. A very persistent band of slate, usually from 1 to 4 inches thick, occurs about two feet from the floor. The floor consists of old soil, often very shaly and carbonaceous towards the top. The roof is variable in nature. Sometimes there is a soft clay shale of no considerable thickness with sandstone above it, and again a soft clay that swells and caves down, extending upward many feet above the coal. When this is the case, a scale of coal is left in the roof to protect the clay from the draught. In the southwestern portion of the mine the slate band rapidly widens to nearly 2 feet and impure streaks appear in the coal, rendering it unfit for use. The pillars of No. 6 mine are now being drawn, preparatory to abandonment.

No. 2 mine lies southeast of No. 6. After describing the latter, little need be added regarding the seam as exposed in it. The dip is about 5° in a southerly direction. An area of inferior coal unfit for use is found in the west workings, corresponding to the area in No. 6. Fig. 5, Plate III, shows a typical section of the seam in this mine.

A second seam of coal from 3 feet 6 inches to nearly 5 feet thick lies below the main seam. The distance between them varies, but is usually as much as 10, at one point 36 feet. Where the distance is unusually great there is much sandstone between them; where less than 15 feet, very little. This coal is very dirty and has not proven satisfactory where they have attempted to mine and use it. The Carbon coal contains low percentages of water and fixed carbon, much gas and ash. It also carries some sulphur. It is the most popular locomotive fuel along the line of the Union Pacific, but does not compare with the Rock Springs coal as a domestic fuel.

The first two of the following analyses represent coal from No. 2 and No. 6 mines, respectively. The third is of a sample from the lower seam:

	1.	2.	3.
Water	7.66	7.89	7.07
Gas	43.77	41.14	39.93
Fixed carbon	44.42	42.81	36.46
Ash	4.15	8.16	16.54

The Union Pacific Company no longer owns the land south of their Carbon mines. The coal basin extends in that direction eight or nine miles. The seams appear to be thicker than at Carbon; whether they are the same or not, is unknown. At Seven Mile Lake ranchmen have made an opening upon a seam of coal that appears to contain less ash than the Carbon coal and to be fully as good or better in other respects. I am not pre-

pared to describe this portion of the basin before making a more thorough examination of it, beyond saying that it probably contains many times the amount of coal that the Carbon mines have produced. The production of the Carbon mines has decreased during the past few years, and will be lessened in the future. The coal now mined is not so good as that formerly produced, and the available reserve ground is limited unless deep mining is attempted between No. 5 and the railroad track. Probably for this reason the railway company has been prospecting in other localities for several years and this year is opening new mines at Dana and Hanna, both in the great basin west of Simpson Ridge. Dana is about twenty miles west of Carbon, upon the main line of the railway. Hanna is about six miles northeast by road from Dana.

THE DANA MINES.

The Dana mine is opened upon a seam of coal where it outcrops in sec. 5, tp. 21, r. 82. The seam dips to the northeast at an angle of 32° to 35°. At the slope there is about 14 feet of coal, of which the lower 7 or 8 feet, separated by a parting from the upper coal, is to be mined. The upper portion of the seam contains several partings and near the top some thin bands of shale. Fig. 1, Plate III, represents a section of the seam as shown in the air shaft. Southeast about half a mile, at a point south of the railway, a boring 70 feet in depth shows the seam to be about 7 feet thick. A northwest opening upon the outcrop show that it maintains the size shown at the main slope for at least several miles. The main slope and manway are each about 700 feet in length, and entries have been driven far enough to prepare the mine for shipment. Two samples taken at a point near the main slope, a little over 100 feet from the surface, gave this analysis:

	1.	2.
Water	11.70	11.30
Gas	41.41	42.01
Fixed carbon	39.65	39.69
Ash	7.24	7.00

This coal is not as good as the old Carbon coal. It slacks and makes more sparks when burnt. The ash is also rather high.

THE HANNA MINES.

The new coal mining town of Hanna is situated upon the northeast quarter of sec. 19, tp. 22, r. 81, west of the sixth principal meridian. Over a year ago the Union Pacific Railway Company began to prospect this region and the work has been pushed actively ever since. It has been discovered that this region contains an immense amount of coal, there being a great many seams and some of them very large. At least three seams are known that have an average of more than 15 feet of coal,

and many smaller ones have been discovered. Some of this coal was found to be practically worthless, some of it of a quality that caused the company to start a town and open a new series of mines. A branch track has been built from Carter Station, a point upon the main line between Medicine Bow and Carbon, to Hanna, a distance of about twenty miles. One mine, No. 1, has been opened and supplied with a powerful hoisting plant. Another, No. 2, is being opened, but is not yet supplied with heavy machinery. The former mine is now about ready to make regular shipments. All of the seams that have been opened occur near the center of the synclinal basin west of Simpson Ridge. The axis of this synclinal seems to pass in a direction a little east of north and through a point near the center of section 21. All of the coal seams developed are upon the west side of the axis. The Laramie rock extends westward for about twenty miles at least, but I have never been more than two miles directly west of Hanna, and am not familiar with the structure from thence to the Ferris coal bank near the North Platte. The three largest seams known are all opened at points near the channel of Chimney Creek, a stream flowing nearly due west towards the Platte River. The distance along the valley from the lower to the upper of the three is about one and a half miles. The central seam outcrops about half way between. The rock west of the lower seam is chiefly a soft, massive, coarse-grained sandstone. A similar rock overlies the seam, but it is interrupted by softer argillaceous strata, which become more abundant eastward until the former seem to disappear. For several hundred feet beneath the central seam there are numerous strata of very hard reddish sandstones that have offered marked resistance to erosion, causing the formation of a prominent ridge, to be referred to later. Between the middle and upper seam the rocks are mostly soft and argillaceous, with numerous hard, thin strata of reddish sandstone and several workable seams of coal. The upper seam is called No. 1, the middle No. 2, and the bottom No. 3. A smaller seam between Nos. 1 and 2 is called the red ash seam.

No. 3 seam dips about 12° in an easterly direction. No extensive tunnels have been run in upon it. Two cuts and some bore holes near the outcrop show it to be from 14 to 24 feet in thickness. The outcrop crosses the valley in a northeasterly direction. The seam has not been traced very far.

No. 2 seam outcrops just east of the prominent ridge of harder sandstones. No. 2 mine now being opened upon it shows the dip to be about 20° s., 35° e. The structure of the seam is shown in Fig. 4, Plate III. The middle band, 14 feet thick, is the one that it is proposed to mine. No. 2 mine is situated but a few hundred yards south of Chimney Spring, which is the gap cut through the sandstone ridge by the main water channel. Another opening has been excavated upon the same seam half a

mile to the northeast, which shows about 20 feet of coal. Besides these two openings there are a few shallow pits and a number of shallow borings along the line of outcrop that determine the size of the seam for several miles and show it to vary in size between limits of 16 and 24 feet, with an average of about 19 feet. The clay band towards the top appears to increase in size towards the north. South of No. 2 the bore hole notes do not mention it; to the north they mention a band of clay at places 6 feet thick, which corresponds to it in position. A smaller seam, where opened about 5 feet thick, lies above No. 2 and below No. 1. An incline about 50 feet in length exposes a perfectly homogeneous breast of coal. The dip is 12° s., 30° e. The roof is shale and the floor carbonaceous clay. The croppings may be traced for nearly a mile. The coal is coarse grained but firm and does not slack badly. All the joints are covered with a thin film that causes the brilliant interference colors of "peacock coal." There are a number of other openings upon seams between No. 1 and No. 2. Some of them are said to show merchantable coal and some not. No. 1 seam is opened by the workings of No. 1 mine for a distance of about 800 feet from the surface. Entries have also been driven, and when the dump is finished the mine will be ready to make shipments upon a large scale. Fig. 2, Plate III, shows the structure of the seam. The upper 14 feet is to be mined. A persistent parting of great regularity divides it into two almost equal bands. There is no slate in the vicinity of this parting. The seam has been traced continuously but a short distance northeast or southwest. In the former direction the outcrop soon disappears beneath the deep soil of Chimney creek bottom. About a mile to the northeast the No. 2 seam, or at any rate one of about the same size and with similar coal, again appears at the surface. A section is represented in Fig. 3, Plate III.

Three prominent faults cut the formation near Hanna. They are nearly parallel with the general dip of the formation and with each other. They are only plainly seen upon the long ridge that follows the outcrop of No. 2 seam. The coal occuring near the surface upon this seam has been burnt and the lower slope of the ridge is covered with a hard dull colored slag and the characteristic deep red fragments of calcined iron-stained sandstone. Chimney creek cuts through the ridge where the most southerly fault breaks it. The displacement in the axis of the ridge is plainly marked and the fault may be easily traced along the surface to the southeast almost to the outcrop of No. 2 seam. Two springs, Chimney spring and one about three-fourths of a mile southeast, are located upon this fault. The displacement as determined by borings is about 120 feet down to the northeast. The second fault crosses the ridge just north of the second opening upon No. 2 seam, already mentioned. The displacement is in the same direction and probably greater than the one just mentioned. The third fault is an upthrow to the north-

east of probably 400 feet or more. It cuts No. 2 seam about one and a half miles northeast of No. 2 mine. I have failed to trace these two faults to the southeast towards the outcrop of No. 2 seam, in spite of the prominent reefs of sandstone that occur in the ground between. This may be due to the fact that they rapidly lessen to the southeast or change their course, or it may merely be that they continue and the observer was unable to distinguish them.

A number of analyses have been made of samples of coal taken from some of the seams described. While all of the analyses were of averages, excepting the two that are called lump samples, they do not show any marked differences in nature, but notwithstanding there seems to be considerable difference in the quality of the coal. No samples were taken from No. 3 seam, as the openings only showed the weathered coal very near the outcrop. No. 2 seam shows a hard, bright coal near the bottom of the cut northeast of the mine. In the mine, however, the coal appears to be soft and, perhaps mechanically, has a tendency to break in mining with the formation of a good deal of slack. No. 1 seam contains much harder and firmer coal that does not make much slack in mining nor does it air slack to any extent when brought to the surface. Most of the coal is of rather fine grain and a fractured face has somewhat the structure of a very fine micaceous rock. Through this, and especially in the lower 7 of the upper 14 feet, there are irregular bands of very bright and shining coal of exceedingly fine grain, having waving bands through it similar to the grain of wood. It is locally called curley coal. The No. 1 mine promises to make a domestic fuel of superior quality. As a locomotive fuel it is hardly equal to the best Carbon coal.

The following is a table of analyses:

TABLE II.

ANALYSIS OF COALS FROM SEAMS NEAR HANNA, CARBON COUNTY, WYOMING.

No.	Description.	Water.	Gas.	Fixed carbon	Ash.
1	No. 1 mine, lump, fine grained	7.64	45.89	45.11	1.36
2	No. 1 mine, lump, coarse grained	8.43	45.88	41.46	4.23
3	No. 1 mine, average lower 5-foo tband	8.43	43.02	41.03	7.52
4	No. 1 mine, lower 7 of upper 14 feet*	9.07	45.80	39.06	6.07
5	No. 1 mine, upper 7 of upper 14 feet	8.13	44.59	42.88	4.40
6	No. 2 mine, upper 7 feet	9.12	41.68	45.36	3.84
7	No. 2 mine, middle 14 feet	9.11	42.51	44.46	3.92
8	No. 2 seam, northeast opening*	10.35	41.36	44.22	4.00
9	No. 1 seam, section 16, upper surface coal*	11.55	43.01	42.19	3.25
10	No. 1 seam, section 16, lower coal	7.98	42.59	44.08	5.35
11	Five-foot seam, section 16, near surface	8.78	40.13	45.12	5.97

*Samples at once bottled and tightly stoppered.

SECTION V.—THE UNDEVELOPED COAL AREAS WITHIN THE UNION PACIFIC TWENTY-MILE LIMIT*.

The more important coal seams along the line of the Union

Pacific have now been described. The undeveloped localities within the limits of the land grant and the proportionate amount of undeveloped coal is immense. It is perhaps no exaggeration to say that one-half of the total area of land within the twenty-mile limit north of the track in Carbon county is underlaid with coal. Unquestionably much of this coal is of inferior, some of it of superior quality. Upon reasoning based upon observation, the writer believes that the area north of Fort Steele and on both sides of the North Platte river, is capable of producing good coal if the proper horizon be prospected. The question of what constitutes the proper horizon for good coal, if there is a definite horizon, will be discussed at the close of this chapter.

The coal area south of the railroad and within the railroad limits is by no means so large on account of the Elk Mountain uplist. The district immediately south of Carbon and included in the Coe & Carter purchase from the railway, contains a large quantity of coal which, as shown at Seven Mile lake opening, is of excellent quality. In size this portion of the Carbon basin does not cover more than 20,000 acres. About 8,000 acres of this was recently purchased after having been partially prospected by a competent engineer, and it seem probable that new mines will be opened here in the near future.

West of Simpson Ridge from this locality the land in the vicinity of Bloody Lake is prospectively valuable. Again there is coal in the Pass Creek Basin east of Rankin's ranch. This synclinal is of small extent however. The only opening exposes a heavy seam of clean coal, which apparently is of poor quality and unfit for commercial use. That there is or is not merchantable coal has never been shown. Little is known of the coal seams in the district lying between Saratoga and Rawlins, further than that seams are to be found. I understand that there are a few openings, but have never seen them. One sample of coal shown me as coming from that locality was of poor grade. About four miles southwest of Rawlins, in a district locally broken and complex in its structure, there is a small mine, the property of Mr. Malachi Dillon, from which much of the coal used in the town is mined. The seam is from 4 to 5 feet thick and the coal usually quite clean. It contains some iron pyrites, but not enough to materially injure it.

West of this mine some four miles another seam of coal has recently been opened. This seam is much higher up in the coal measures. The coal is bright and clean and there is about eight or nine feet of it. While the Dillon coal does not slack and will answer for all the requirements of domestic coal or steam producer, the other coal will slack and will answer for such uses. The first two of the following three analyses represents samples

*Every other alternate section of land within twenty miles of the railway was granted to the railroad company. This grant included coal land. The twenty-mile limit refers to the boundary beyond which no land was granted to the company by the government.

of the Dillon coal, the third sample from the higher seam:

	1.	2.	3.
Water	7.47	5.19	19.16
Gas	36.05	37.05	33.11
Fixed carbon	51.56	48.50	41.07
Ash	4.32	9.25	3.64

Both of these seams outcrop upon the east side of a synclinal lying between Rawlins Mountain and the Bitter Creek uplift. Passing west to Separation Creek there are other seams of coal which have been found deficient where prospected. Similarly situated, but upon the opposite side of the synclinal, the coal at Hallville and near Point of Rocks was found to be practically worthless. All of these seams, with the exception of the Dillon, are high up in the Laramie. The Dillon appears to be very near the base.

It has been shown that the Rock Springs coal mined lies near the base of the Laramie rocks. In the extract quoted from the survey of the 40th parallel it is seen that the Laramie strata pass north from Rock Springs for some distance and swinging westward in a bold curve, finally return in a southeasterly direction and cross the track. Should the rule hold that good coal is likely to be found at the base of the Laramie it would appear that this outcrop would offer a splendid field to the prospector, especially where the coal measures north of Salt Wells are fractured by eruptive rocks (Leucite).

SECTION VI.—COAL LANDS WITHOUT THE RAILWAY LIMITS IN CARBON AND FREMONT COUNTIES.

There is a very large coal area south of the twenty-mile limit in the region drained by the Snake River and its northern tributaries. There are also rumors of excellent coal being found there, but the writer has never been over this portion of Wyoming and knows nothing authentic concerning the quality of the coal.

North of the twenty-mile limit and south of the Sweetwater River there is also a large undeveloped coal area that is capable of supplying good coal in large quantity. At a few places the geology of the country is very complex, and is not yet thoroughly understood. The general structure, however, is simple and easily understood. The writer has devoted several consecutive weeks to work in this region and has prepared notes for a geological map of it, but at present he can only spare space for a very brief description of it.

Rawlins Mountain is the crest of an uplift which has thrown strata far older than the western coal measures above the level of the surrounding country. The strata dip radially away from the center of this uplift, and at the base of the mountain the older rocks pass beneath the surface and make room for the

younger, until finally the coal-bearing strata appear at distances inversely proportionate to the angle of the dip. To the south the dip is steep and coal seams are found a few miles from Rawlins. To the east and west they only appear twelve or fifteen miles from the town, while to the north toward Whisky Gap they do not appear for thirty miles; in other words, the Rawlins Mountain uplift forms, so to speak, a great illiptical island of older rocks, about which the coal measures outcrop. This leaves a rudely semi-circular line of outcrops of coal veins north of the railroad limits. Passing from the limits in township 24, range 90, the croppings extend north through township 25, range 89, north and east through township 26, range 88, and thence in a rudely southeasterly direction to township 25, range 85, and beyond into the Coal Creek basin, again within the railroad limits.

In townships 25 and 26, ranges 89 and 90, the coal-bearing rocks dip to the west and northwest until they disappear beneath eocene strata. Even to Muddy Creek they unquestionably underlie a large area. From the latter point southeast the width of the belt is limited by the base of the Ferris and Seminole Mountain uplift, which cause the lower cretaceous rocks to rise to the level of the surface, now with a southerly and southwesterly dip.

The Muddy is a sluggish stream which flows into the Sweetwater River. Considerable development has been done upon several of the coal veins which outcrop on certain branches of this stream and at points which are all less than fifteen miles from the Sweetwater. The analyses of samples of this coal taken at distances approximately 150 feet from the outcrop upon the slope of the seam are unsatisfactory. They represent a class of coal that is not fit to supply the northwest trade, and the land will have little value as coal land unless better coal is discovered. The analyses made are as follows:

	1.	2.	3.
Water	13.13	13.61	14.30
Gas	35.57	36.00	34.42
Fixed carbon	45.40	46.24	40.03
Ash	5.90	4.15	11.25

Passing southeast from the last locality along the base of the Ferris Mountains the surface is largely covered with sand hills, and is wholly unprospected. It is only after the divide between Sand Creek and a tributary of Hurt Creek is passed that coal croppings with some developments upon them are to be found. These coal lands extend from the base of Bradley's Peak southeast along the base of the Seminoe Mountains to and across the North Platte river. From the river westward the coal lies in a synclinal basis, and outcrops in two parallel lines. Towards Brradley's Peak this simple structure is complicated by a system of faults which are imperfectly understood.

The seams of this region have been opened at a number of points, all north of the railroad limits. Only a few will be mentioned. The westernmost opening is above the Fieldhouse ranch, where a tunnel has been run by ranchmen upon a 7-foot vein. A thin layer of clay (from one to six inches) shows in places about two feet from the foot of the vein; otherwise the coal is perfectly clean.

The Penn Mining Company owns some land two or three miles below the Fieldhouse bank. They opened the vein through a slope. The coal is about five feet thick, and uniform in character. It does not slack, as evidenced by a pile at Seminoe, which has lain in a shaft house over a year.

The third opening is at a point about two miles above Miller's ranch. There are here two veins about 50 feet apart, each 12 feet thick. Gopher holes indicate the presence of other veins in the same group; but these have not been opened. The first work done here was upon the upper of the two veins. A slope was run for 100 feet or more, nearly upon the strike of the coal, and a shaft was sunk for ventilation. The roof of the slope caved about eight years ago and no work has been done upon the vein since. The coal was examined through the shaft. While untouched for eight years, and with each year's snow filling the shaft and melting, the walls still stand firm and unslacked, althogh much altered by contact with air and water. No analysis of the coal was made because of this change; but from its appearance it is believed to be of excellent quality. When the first slope caved, the lower vein was opened in a similar manner. The coal is reported to be inferior to the upper vein in quality. Notwithstanding, it certainly is the best coal now mined in Carbon County. With the exception of a thin streak of boney coal (2 to 4 inches) near the foot of the vein, the coal is perfectly clean. It shows no iron pyrites, is bright, close grained, and break into cubical blocks when struck with a hammer. The dip at the Miller bank is between 50° and 60°. At the two localities described immediately preceding, the dip is not over 10. The three following analyses will show the composition of these coals: No. 1, Miller opening, 12-foot vein; 2, Penn Mining Company; No 3, Fieldhouse opening.

	1.	2.	3.
Water	9.62	9.40	11.42
Gas	36.03	36.90	37.87
Fixed Carbon	51.12	47.30	48.54
Ash	2.33	6.40	2.17
Total	100.00	100.00	100.00

While analyses of these coals indicate, and actual trial proves that there can be no question but that they are excellent domestic fuels, and while they appear to be in every way suited to the ordinary purposes of commerce, yet there appears to be one diffi-

culty connected with the lands in this particular district. That is, they appear to be badly faulted and broken and it is by no means sure that large areas will be developed upon which extensive seams may be opened. Thus at the Miller bank, while the surface is largely covered with sand dunes, enough is revealed to show that the country is exceedingly complicated it its structure. It is two miles or thereabouts to the base of the mountains. In that distance there are two synclinals and an anticlinal and the coal basin appears to be scarcely a quarter of a mile wide. The writer at first thought that this was not the case, and that there was a basin nearly two miles in width underlaid by coal, but careful investigations during the past summer have convinced him that he was wrong. Further west, toward the Penn opening, the synclinal structure disappears and a series of faults appear to take their place. Still further west some of these faults appear to unite and form one great uplift which throws the metamorphic rocks of Bradley's Peak in direct conjunction with the Laramie strata. The displacement of this fault cannot be less than 1,000 feet.

It is a matter of regret that time and space will not permit a fuller description of this very important district, covering the entire area embraced within this section. That good domestic and steam fuel occurs in several places is certain; that it occurs in large and unbroken areas is almost certain. It must also be remembered that there are large seams of inferior coal, consequently those desiring to find the merchantable coal will be compelled to prospect carefully and systematically and venture ahead as each preliminary step is proved successful. Otherwise, they may only add others to the already too long list of failures that have resulted from careless or unintelligent prospecting in the western coal fields. Should prospecting prove successful the entire district will be found accessible by railroads both from the north and the south.

SECTION VII.—THE COAL FIELDS OF NORTHEASTERN AND CENTRAL WYOMING—THE POWDER RIVER COAL AREA.

The coal area of this region is immense in extent. One field occupies the basin between the Black Hills and the Big Horn Mountains, and extends from far within the confines of Montana to and across the North Platte River. This field, called for convenience the Powder River coal field, occupies about 15,000 square miles of the surface of Wyoming, and is capable of producing many thousand million tons of coal. The same or different seams may be seen outcropping every few miles, so that it is very easy to reach the coal, and the numerous settlers have almost always a cheap and convenient fuel at hand—a very important circumstance when it is remembered that wood of any kind is often scarce. But even where wood is abundant coal is usually preferred. In Johnson county, near Buffalo, there are

two small mines that supply the town and military post. Similar mines are opened near Sheridan. Many other openings of limited extent supply the individual settlers who do not file upon the land because coal is so abundant. But, as far as known, the coal of this district has little other use than that of supplying a local market. The present discoveries do not warrant a belief that it will furnish a fuel that will merit transportation and do the work that commerce demands. So long as the carrying facilities are so utterly inadequate, and it does not make a great deal of difference whether it takes six tons or ten to last a family through the winter, this coal will answer, but when the value is enhanced by the cost of transportation, better coal is required. For this reason, except for local consumption, coal mining in the Powder River field, along the line of the Elkhorn & Missouri Valley Railroad, has not proven very successful. Certain people took up and bought about 3,400 acres of land on Shawnee Creek, near this line, and made expensive developments, only to find that their coal would not answer the requirements of trade and that the money they had invested was a dead loss. Two other mines have been opened up further west, immediately on the line of the railway. With the advantage of low rates they are able to sell about 40,000 tons of coal annually. The market extends east through Nebraska to Omaha and to Sioux City, Ia. While the coal is light, it burns freely and without the formation of soot. For these reasons and its cleanliness it sometimes is sold for domestic purposes before stronger coals; but there is not enough sold to warrant the belief that they will make large mines. This prediction does not seen unsafe when it is considered that these coals are not good steam producers and are unfit for locomotive use.

THE RATTLESNAKE COAL FIELDS.

This area lies north of the Rattlesnake Mountains and extends from the North Platte River, below the mouth of the Sweetwater, northwesterly, nearly to Lander. A large portion of this field is covered with younger rocks, which lays over the coal croppings. The coal, like that of the Powder River field, is a lignite, and serviceable to the ranchers as a convenient fuel, but as far as known is not suitable for the market. The western portion of this field, which includes the coal seams near Lander, is excepted from this statement. I am not yet prepared to speak of it.

The question of finding a better fuel in the Powder River and Rattlesnake coal areas is a very important one. If a really superior coal is uncovered, it will probably occur at a lower horizon than any of the seams at present discovered. In the last named area, the coal certainly occurs at a much higher horizon than at Rock Springs. The writer believes that the same is the case in the Powder River area, but he is not positive of it. The prospector should pay attention to the ground upon the outside

of the basin and nearer the hills or mountains that border it. Thus at Buffalo and Sheridan the sandstones lying west of the lowest known seams should be searched for coal.

It will be shown later that the new Crook County mines occur in the Dakota sandstones, a formation much older than the normal Wyoming coal measures. Southwest of Dayton, in Sheridan County, a seam has been opened in the same formation. The opening only exposes a highly carbonaceous shale that will burn, but will leave 30 to 35 per cent of ash. Should the seam be followed along the outcrop it might or might not show a good grade of coal. It can only be said that in the same formation in Crook County there appears to be large areas where the coal is equally poor.

The Dakota sandstones along the eastern base of the Big Horn Mountains forms a very prominent outcrop. They may be easily recognized, as they form the first prominent ridge or reef without the red sandstones and clays that lay at the base of the main range. They consist essentially of hard massive sandstones with some fine conglomerates and some shales near the centre.

SECTION VIII.—THE COAL FIELDS OF EASTERN CROOK COUNTY.

The great foot-hill table-land or mesa of the Black Hills in Wyoming, cut by deep, more or less precipitous canons, but otherwise standing up above the surrounding country, consisting essentially of hard, coarse-grained sandstones and fine conglomerates of white and yellowish colors, overlaid at the base by dark-colored shales, underlaid by light-colored clays and other variegated strata, can not escape the notice of the most careless observer.

Owing to the difference in hardness from the rocks below it, the mesa has a tendency to present a bold escarpment towards the center of the hills. Owing to the at first nearly horizontal position of its strata, it slopes but gently outward until the final steeper inclination of the strata causes it to pass down to the level of the plains at a slope entirely dependent upon the angle of dip.

This prominent mesa is composed of what is known as the Dakota group of rocks. Recently new discoveries of coal have been made in it, and for this reason it is now of special importance.

AREA.

It is here sufficient to say that the Dakota groups of rocks in Crook County extend from a point on the South Dakota line southeast of Jenney's Stockade in a direction west of north through townships 45 and 46, range 61; townships 47 and 48, range 63, and township 51, range 66. From thence onward it passes northward around the west side of Missouri Buttes. The belt thus described varies considerably in width but will average fully six miles. Besides this the Dakota forms the surface rock

over a large portion of the territory lying between the north side of the Bear Lodge Mountains and the Belle Fourche River.

Allusion has already been made to the canons which cut deep into the mesa. This applies not only to those of the large streams, but to innumerable branches which come in from all directions. These canons are so deep that they all cut down through the coal veins and expose them outcropping on either side, and in the majority of cases they even cut entirely through the Dakota rocks and into the Jurassic clays. So frequent and near together are they in places that they do not leave areas of unbroken ground sufficiently large for mining purposes. It is only in those places where there are few canons that large pieces of ground are left with uninterrupted coal veins beneath them.

Further, although there are few places where the Dakota does not show some indications of coal, there are many where the veins are too thin or impure to work. As a consequence there is a very large portion of the area in question that will prove unproductive, and it is only where good coal is found underlying large areas and in veins sufficiently thick that mines will be eventually opened.

In spite of these very considerable limitations there are large, unbroken tracts of land, as yet unprospected, that may or may not afford mines. The few openings now to be mentioned only mark a beginning of the search for good coal in the Dakota rocks of Crook County

The qualities which render this coal desirable are: (1) They contain less moisture than any other coals yet discovered. (2) They do not slack. (3) Some of them coke. The difficulty will be to find the coal possessing these qualities and also having a low percentage of ash. The ash and in some places the sulphur are the chief drawbacks.

Important development work has been made on Hay Creek, north of the Bear Lodge Mountains, in township 54, range 61; at the Brier Hill Bank, on Skull Creek, in townships 47 and 48, range 63, and at the Mount Zion mines, in township 46, range 61.

THE HAY CREEK MINES.

As a result of the necessity for good fuel at the Black Hills mining towns, a search for coal was instituted long ago, and the Hay Creek veins were discovered over ten years since. To-day several slopes have been run in on the coal. Some of these have caved in on account of insecure timbering and the unsatisfactory character of roof and floor. The Barrett and Fox mine is now cleaned out. These workings expose two veins of coal lying about 20 feet apart, and separated by fireclay and sandstone. The bottom bed lies about 30 or 40 feet above what I consider the top of the Jurassic formation. Each of the veins appears to be about 4 feet thick. At a point about three-fourths of a mile west of the Barrett main opening the lower vein is said to be 7 feet thick. * * *

The following analyses were furnished me by Mr. Barrett, the first two being made by the chemist for the Chicago and Northwestern Railway, the last by Mariner & Hoskins, of Chicago:

	1.	2.	3.
Water	8.18	8.74	9.02
Gas	41.95	41.20	39.90
Fixed carbon	40.12	39.91	39.74
Ash	9.75	10.15	11.34
Total	100.00	100.00	100.00

In the latter part of July some other men were prospecting in the Jurassic clays south of the openings already described. They found a streak of carbonaceous matter along the bed of the creek, which they followed in some distance, and at that time they were sinking a shaft below it through fire-clay, containing pieces of wood that had been partly changed to coal and the remainder petrified. There is a rumor that they finally struck a vein of coal in their shaft.

THE BRIER HILL COAL.

Two tunnels, each 60 feet in length, have been run in upon the coal vein underlying this property. The discovery tunnel shows the vein to be 8 feet 4 inches thick, of which the upper $6\frac{1}{2}$ feet is chiefly of dull, lustreless color, and has a brown streak. The bottom 2 feet is bright, fine-looking coal.

The other tunnel, situated a few hundred yards distant, shows the vein to be here only $6\frac{1}{3}$ feet thick, of which the upper 18 inches is of dull color, then 3 feet 4 inches of bright coal, and the bottom streak of duller color.

Analyses of this bright-looking coal show it to contain a very large amount of gas, a low percentage of fixed carbon, and a low percentage of moisture.

Water	5.25	5.75
Gas	41.70	42.13
Fixed carbon	44.98	44.34
Ash	8.07	7.78

These samples are from selected pieces which were sent me from Crook County about two years ago. My own samples give the following results:

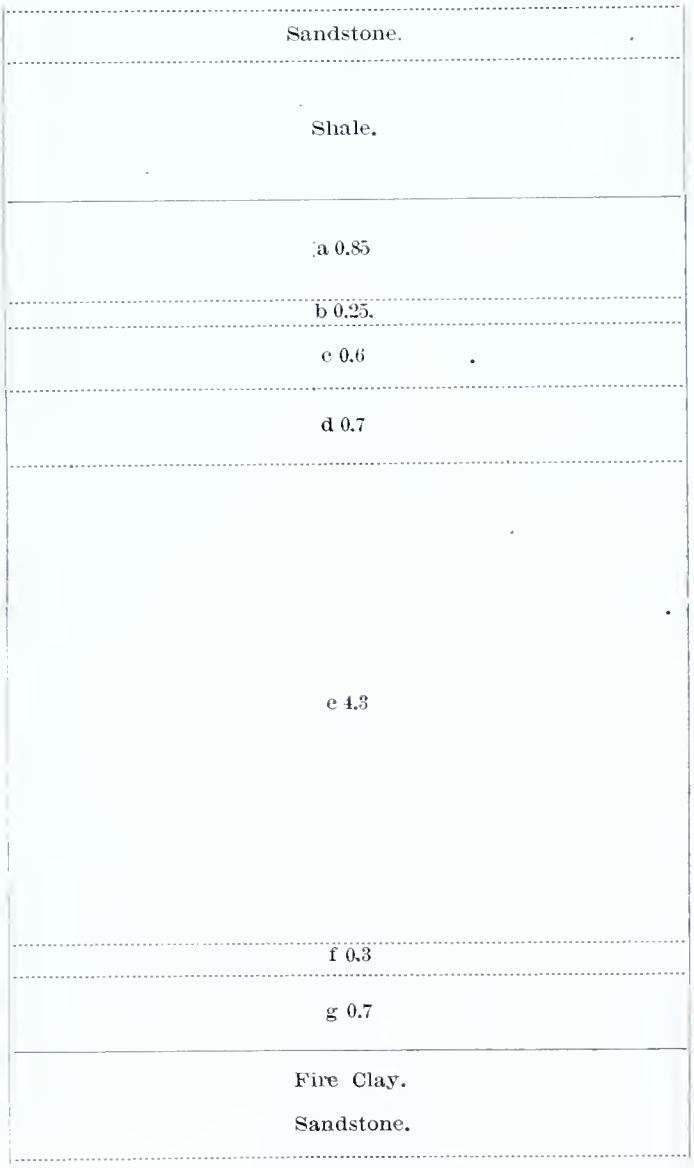
	1.	2.
Water	6.81	8.11
Gas	35.66	30.31
Fixed carbon	40.81	42.28
Ash	16.62	19.30

It will be seen that the general average of the vein in the two tunnels (Nos. 1 and 2) is unsatisfactory in that the percentage of ash is very high. No. 3 is the best. It represents an average of the 3-foot 8-inch streak in the center of the 6-foot 4-

inch breast. A streak of this thickness would pay to mine if it were uniform. I fear from the nature of things that this streak will be irregular.

THE MOUNT ZION MINES.

This locality was visited in July last. The writer was treated with every courtesy by those in charge, and wishes to here express his appreciation of the kindness shown him.



Jumbo Seam.

These mines are situated in township 46, range 61. The Jumbo Claim is in the center of section 29, the Antelope is contiguous upon the west. The other coal claims adjoin. The owners have and are investing large sums of money. Besides

the developments actually made upon the coal seam they have purchased about 6,000 acres of coal land, freighted in and set up a large saw mill, graded many miles of wagon road, built many houses, located a town site, made hundreds of thousands of bricks, and brought in and set in place an extensive mining plant of the most improved type. In addition to this the Burlington system is extending its Broken Bow branch about 200 miles in order to connect with the mines by the time they are ready for production. When the mines are opened and ready to ship coal and the railroad connection completed the total outlay of money can not fall far short of $2,500,000. Consequently, the success of these mines is a matter of great importance to those who have invested this money.

Prospecting in the vicinity of the Mount Zion mines was commenced nearly two years ago. At first the results were so unsatisfactory that the search was nearly abandoned. The coal seams found were thin and impure—nothing more nor less than slate. About section 29 the outcropping coal had been mostly burnt. But one point was found that the old fire had spared, and the discovery was made here which has led to the investments described. A point was selected to the west of this discovery, where a gulch several hundred feet deep, running east of south, cuts down through the coal and leaves the seam outcropping on either side about 55 feet above the water channel. Two mines are being opened here, the one on the east called the Jumbo, the one on the west called the Antelope. They will each have a capacity of 100 tons per hour. The coal was found to be burnt back of the crop for a distance of 200 feet. When the fire had worked back this far the whole mass of the overhang hill caved in and smothered it out. The following were the developments that I saw at the mines: (1) The Jumbo discovery tunnel which starts at the croppings and follows the vein in 78 feet along the floor, 69 feet along the roof of the seam. (2) The Antetope air-way, which strikes unburnt coal 200 feet in and passes 12 feet into it. (3) Two small prospect tunnels run, one for each mine to determine the level at which the output tunnel should be started. These pass through the burnt zone but do not enter into the coal far enough to show its quality. (4) A similar tunnel about 300 yards up the gulch from the Antelope main entry. (5) The Antelope output tunnel and the Jumbo air-way and out-put tunnel, none of which had reached the solid coal in July. (6) Certain short tunnels on the crop of vein in various gulches, none of which showed solid coal. Of these workings, aggregating not more than 1,200 linear feet of tunnels, only two showed the solid vein. These together were in solid coal for a distance of less than 75 feet.

Before describing them it may be well to mention how the samples for analysis were taken. A suitable point was selected as near the face as practicable and a tape hung from the roof to

the floor. Then the various bands in the vein showing any visible difference in appearance were measured and marked off by small pieces of white clay stuck to the face. Each band and its thickness were entered in a note book and lettered. Then samples were taken as judgment directed. In taking a sample a cloth was spread on the floor and a groove of uniform width and depth was made vertically across the bands to be assayed. These pickings were crushed and carefully quartered to a convenient bulk.

The Jumbo discovery tunnel is 69 feet under cover. The vein is 7.7 feet thick. Over the coal there is little more than 1 foot of compact slate with sandstone above it. Below the coal there is found 2 to 6 inches of fire-clay and then white sandstone.

The cut represents a diagram from my note-book. The letters represent the various bands distinguished, the figures, their thickness in feet and decimals of feet.

Streaks A, C, E and G are bright-looking coals, of usually uniform texture and luster; B and F are shales of grayish color; D is streaked in appearance, having irregular bands of coal alternately bright and dark. I was informed that it was the intention to mine the coal by machinery and to cut in on streak G and shoot down from streak A, and in breaking up the coal to throw B and F aside. From analyses of coal similar to streak D from the Antelope, I think this will not yield good results. And in my opinion only streaks E, F and G will be mined, of which F will be thrown out. I took two samples of this streak, one from a point 33 feet under cover and one from a point 5 feet from the face. The analyses gave:

	1.	2.
Water	5.17	8.10
Gas	41.40	42.57
Fixed carbon	39.98	37.51
Ash	13 45	11.82

No. 2 was kept in an air-tight bottle for a certain purpose. It will be seen that the moisture is higher than in No. 1, which represents the coal as it would arrive upon the market. I have not yet made other analyses taken from this opening.

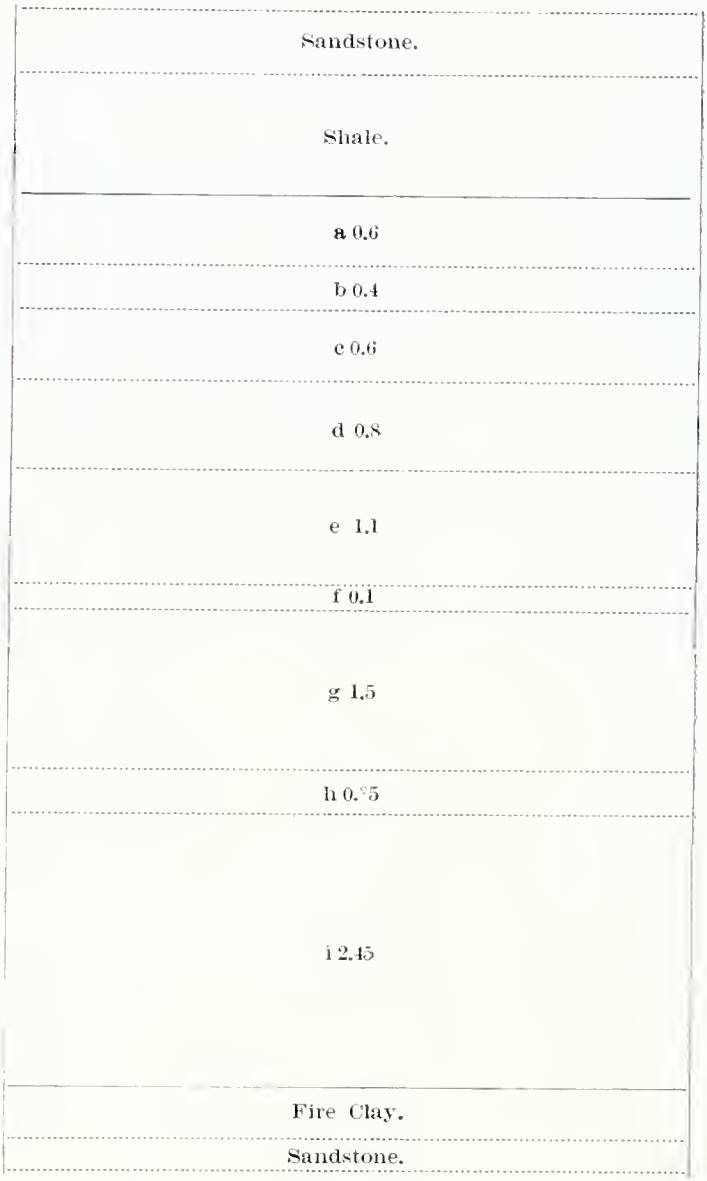
The next cut is a similar representation of the vein as exposed in the Antelope air-way. Streaks A, C, E and G represent the cleaner coal. Streaks B, F and H the shale, and streak D a band of so-called boney coal. It will be seen that the two sections closely agree with each other, only the bottom streak is thicker and a new streak of bone (F) has appeared in the Antelope tunnel.

The following are analyses of samples taken from the Antelope:

	1.	2.	3.	4.
Water	5.86	6.44	6.56	3.32
Gas	42.17	39.75	37.96	38.94

Fixed carbon.....	42.22	41.34	40.09	31.73
Ash.....	9.75	12.47	15.39	26.01

These analyses represent samples of the following streaks:
No. 1.—Streaks E to I, inclusive, except F and H.
No. 2.—Streaks A to I, inclusive, except B, F and H.
No. 3.—Streaks E to I, inclusive.
No. 4.—Streak D.



Antelope Seam.

There can be no doubt but that specimen samples showing far less ash, and equally as good in all other respects, could be taken. In fact, I have made analyses in which the ash was not over 7 per cent., but the analyses given above represent averages

In my opinion it will be necessary, unless the quality of the seam greatly improves, to abandon all streaks above E and throw aside F and H. Otherwise the percentage of ash will be great. While the ash in these coals is high the moisture is low, and if we add the percentage of gas and fixed carbon together it will be seen that the total combustible matter does not compare unfavorably with the Union Pacific coals. Further, this coal will probably yield more heat to the per cent. of combustible matter than the others.

If the most conservative view of the portion of the vein to be worked is taken, each opening shows about 5 feet of clean coal and from 4 to 5 inches of slate, and if we infer that a large area contains upon an average a like thickness and grade of coal, the vein will yield over 3,500,000 tons to the square mile. This question of continuity in thickness and quality is an exceedingly important one.

With the latter field the writer has mentioned all the coal areas in Wyoming which he has personally inspected. He has not yet examined the unquestionably large areas of southern Albany and Carbon Counties, which he understands are of great promise, nor the coal fields of Uinta County and the Big Horn Basin. Although he has heard reports and rumors of excellent coals in all of these large fields, he is as yet unable to report upon them, for the want of personal knowledge. Consequently, unless it is remembered that this paper upon Wyoming coal fields is incomplete and that it leaves out large and promising areas completely, injustice will be done the subject.

SECTION IX.—CONCLUSION.

Thus far large seams of coal have been opened in Wyoming that are adapted to most of the purposes of trade, but especially to domestic use and steam making. No coking coal fit for the reduction of iron ores has yet been discovered, unless coke from portions of the Crook County seam prove to be available. There is now an urgent demand for coking and for the better grades of coking coal, in localities tributary to the Northwestern and Burlington Railway systems, and even in the vicinity of the Union Pacific Railway. In consequence of this demand an active search is being made for such fuel and the question of the proper manner of conducting such a search is a very important one. Thus far there has been, with few exceptions, little or no prospecting upon a combined, practical and scientific basis, because the laws governing the quality of the western coals are not well understood, and also because those prospecting have had little experience with the western coal formations, and are too apt to apply information that has force only in the eastern coal fields.

The writer has given much thought to this subject, and while he has candidly to confess that there is much that he does not understand, yet he thinks he has reached a few conclusions that

will be valuable to those at least who have not had any large experience in prospecting in the western coal formations.

In the foregoing description of the coal lands of Wyoming, it has been stated that the total area which may contain coal approximates 30,000 square miles. It has also been shown that while there is an immense quantity of good coal already developed and undoubtedly more as yet undeveloped, even undiscovered, by far the larger portion of the known coal in this enormous area has little or no commercial value. Consequently, it stands to reason that the chances are greatly against striking good coal upon a seam chosen at hazard. Not only is the coal as yet discovered in some of the fields altogether of inferior quality, but there is not a single locality containing a number of seams all of which contain uniformly superior coal. Thus at Rock Springs, only the four lower large seams are now worked. The sixth large seam from the bottom of the measures was abandoned on account of the inferior quality of the coal. It has been mentioned that the Dillon seam near Rawlins, the Bull Springs seam and the Miller seam all contain a superior grade of coal, while the seams near Hallville, Separation, and some, at least, near Whiskey Gap, show only inferor grades. At Hanna, in Carbon County, there are also many seams, some of which contain merchantable, some an inferior grade ot coal. It may be seen from this that little can be taken for granted and that it is not safe to invest in coal land simply because there are valuable mines near by. Even when two mines are near together, and upon the same seam, it may be found that there is an appreciable difference in the quality of the coal they produce. The first question to be asked by the prospector is where should he begin to look for good coal. At Rock Springs, near Rawlins and in the Hurt Creek Basin, the good coal appears to lie low down in the Laramie, while higher up, at Separation, Hallville, and in Muddy Gap, the coal seems to occur at a higher horizon. On the other hand, the higher seams at Hanna seem to contain the better quality of coal. In spite of this important exception, the writer believes that other things being equal, the seams occurring near the base of the Laramie will afford the best results, and that while it will not do to neglect those higher up, the lower seams deserve the most attention.

The coal seams having been discovered the important question is: What is the commercial value of the coal? There are several causes which render much of the western coal worthless. Among these are the presence of excessive amounts of water in the composition of the coal, of sulphur and of ash. Water is objectionable because: (1) It causes the coal to slack and fall to pieces when it is subjected to the action of the atmosphere and the jar of transportation and handling. (2) It deducts from the amount of combustible matter in the coal. (3) It takes a portion of the heat of the coal to evaporate it. (4) It causes the coal to spark and fly to pieces when burnt. (5) It is generally

associated with other deterious constituents which deduct from the heat-giving power. Sulphur and ash are objectionable for obvious reasons.

The quality of the coal may be approximately determined by its microscopic appearance, especially after it has been exposed to the weather for a few weeks; but it is only by analysis that it may be classified. It is only by a careful ultimate analysis that close distinction in the grade of coal may be drawn. Valuable empiric knowledge may be had by assaying coals by the methods in common use and comparing the results obtained on samples whose practical value is known with those obtained on samples from new localities. Thus the less the invisible water the more the fixed carbon; the less the ash, the heavier the flame, the better the coal. The following analyses will show what I mean:

No. of analysis.	Water.	Gas.	Fixed carbon.	Ash.	Flame.
1.....	5.75	42.13	44.34	7.78	Very heavy.
2.....	8.59	38.91	49.74	2.76	Heavy.
3.....	9.61	34.97	53.97	2.76	Heavy.
4.....	11.70	41.41	39.35	7.24	Light, sparky.
5.....	13.33	32.69	49.93	4.05	Light, sparky.
6.....	22.27	35.74	41.18	0.81	Very light and sparky.

No. 1 has the least moisture and will stand transportation better than and of the other coals. No. 2 has more fixed carbon and less ash, but more water; it is an excellent proven fuel. No. 3 is equally as good as No. 2, but has never been shipped. No. 4 can be used as a locomotive fuel, but is less satisfactory than the preceding. No. 5 will burn readily when freshly mined. It slacks badly, will hardly stand transportation and will not furnish much heat. No. 6 is a lignite, practically worthless for all purposes of trade. When this method of analysis is adopted, and found satisfactory, the precaution should surely be taken to haul a number of tons to some point where it may have a practical trial upon a scale sufficiently large to test its quality. Where the quality is proven and found satisfactory, the next important question is, is there enough of it? Does the seam maintain asatisfactory average thickness? Are there areas in it where slate does not occur in quantity great enough to interfere with cheap mining? Does the seam lay in large blocks unbroken by faults of sufficient displacement to interfere with mining.

In order to discover coal seams that fulfill all the requirements above set forth, a systematic search is demanded. It seems to the writer that the most reasonable method of prospecting embraces a series of successive steps. These steps, which require a progressive expenditure of money, are as follows:

(1.) The discovery of coal bearing strata.

(2.) The preliminary development of such lands to discover coal of good quality.

(3.) Continued development where good coal has been found to discover unbroken areas big enough to furnish a large amount of coal.

(4). The purchase of such lands and final development by opening up mines and placing them in condition to produce and ship coal.

The first step is easily accomplished. The prospector has only to choose the fields most convenient to the market to be supplied, and to begin at once upon the second. The croppings, changed by surface action, indicate but little. Coal beneath the surface has to be reached. This may be done partially by examining the openings already made and by having new openings excavated as far beneath the surface as necessary. Usually the distance is not great, and the cost but a few hundred dollars. The third step is taken when good coal is found, and not before. First, a careful study of the surface should be made. If this is satisfactory, the land should be filed upon by a declaratory statement, which costs about 2 cents an acre, and holds the right to it for one year. Then prospecting should be continued by openings along the coal croppings and diamond drill borings back from the crop. The fourth step presupposes success in the previous three. The necessary quality and quantity is proven. Only now should the land be purchased, the mines being opened by a system carefully planned to suit the ground, and connection made by rail between the mines and market. It is easily seen that the only large outlay of money required in prospecting by this system is after the first three steps have proved satisfactory and success is assured. When the great outlay of capital, necessary for opening coal mines and connecting them with the market is considered, it may seem that such a simple and fundamental course as that here recommended would be well understood and that it was scarce worth while to formulate it. While such a course is adopted by some, the writer could mention cases where large sums of money have been lost by ignoring it. Perhaps he could predict some failures for the future which may be due to the same cause.

Before closing, a few words should be said regarding the occurrence of coking coals. The Crook County coal cokes; whether the mines will or will not furnish a merchantable coke is not yet determined. But this coal occurs near the base of the Dakota sandstones, which is an older formation than the Laramie. The occurrence of coking coal and anthracite in the latter formation may be regarded as phenomenal. They are found in Colorado; they may be found in Wyoming. I understand that it is usually if not always found in Colorado where eruptive works have broken up through the coal measures, and heated up the rocks sufficiently to metamorphose non-coking into coking coal or anthracite according to the intensity of the heat. In Wyomine coking coal may be searched for where there are seams in

the Dakota rocks and also where eruptives have broken through the Laramie. Such a condition exists north of Salt Wells, near Rock Springs, and upon the northern drainage area of the Little Snake River. Whether these eruptions have effected coal seams or not has, I believe, never been determined. It would seem worth while to investigate such localities.

TABLE III.

Production of Wyoming Coal Mines from 1868 to 1887 inclusive.*

Years.	Carbon.	Rock Springs.	Almy.		Fremont, Elkhorn & Mo. Valley R. R. Co.	Private Mines at Rock Springs.	Twin Creek.	Total.
			U. P. Coal Departm't.	R. M. C. & I. Co.				
	Short tons.	Short tons.	Short tons.	Short tons.	Short tons.	Short tons.	Short tons.	Short tons.
1868.....	6,560	365	.....	.....	.....	.....	.....	6,925
1869.....	30,482	16,933	1,967	.....	.....	.....	.....	49,382
1870.....	54,915	20,945	12,454	16,981	.....	.....	.....	105,295
1871.....	31,748	40,566	21,171	53,843	.....	.....	.....	147,328
1872.....	59,237	34,677	22,713	105,118	.....	.....	.....	221,745
1873.....	61,164	44,700	22,847	130,989	.....	.....	.....	259,700
1874.....	55,880	58,476	23,006	81,699	.....	.....	.....	219,061
1875.....	61,750	104,664	41,805	92,589	.....	.....	.....	300,808
1876.....	69,060	134,952	60,756	69,782	.....	.....	.....	334,550
1877.....	74,343	146,494	54,643	67,373	.....	.....	.....	342,853
1878.....	62,418	154,282	59,096	57,404	.....	.....	.....	333,200
1879.....	75,424	193,252	71,576	60,739	.....	.....	.....	400,991
1880.....	100,433	244,460	100,234	82,684	.....	.....	.....	527,811
1881.....	156,820	270,425	110,157	90,779	.....	.....	.....	628,181
1882.....	200,123	287,510	117,211	94,065	.....	.....	8,555	707,764
1883.....	248,380	304,495	111,713	78,450	.....	.....	36,651	779,689
1884.....	319,883	318,197	150,880	68,471	.....	.....	45,189	902,620
1885.....	226,863	328,601	164,441	70,216	.....	.....	17,207	807,328
1886.....	214,233	359,234	155,547	100,341	.....	.....	.....	829,355
1887.....	288,358	465,444	196,913	164,510	5,093	50,000	.....	1,170,318

*Mineral Resources of the United States, David T. Day, Geologist, in charge. Calendar year, 1887.

CHAPTER II.

IRON ORES.—THE HEMATITE DEPOSITS OF THE HARTVILLE DISTRICT.

The most important iron deposits thus far discovered in Wyoming are in Eureka Gulch, about one mile northeast by east of Hartville, in section 7, township 27, north range 65, west of

the 6th p. m., and in section 5, of the same township, where a gulch tributary to Whalen Canyon exposes the ore. The region in the vicinity of the iron ore deposits is naturally a high plateau; cut to a depth of several hundred feet by numerous deep ravines or canyons. These gulches are narrow and have steep, often almost precipitous sides. The average ascent from the water channels to the plateau usually exceeds 15°.

Two classes of rocks may be distinguished, viz: Certain flat lying strata of limestone and quartzites, forming the surface over the plateau and locally called the "cap rocks," and a series of greatly tilted and twisted metamorphic rocks, commonly called slates. The latter come to the surface and are exposed to view in the gulches. The metamorphic rock consists essentially of talcose and chloritic slates and siliceous dolomitic marble. They apparently occur in alternate heavy belts and show very distinctly the bedding planes standing almost vertically. Sunrise Park consists of a basin formed at the junction of several gulches. The slates are exposed over the bottom and nearly half way up the hillsides, when they disappear beneath the cap rocks. The structure in the vicinity of section 5 is similar. Cap rocks cover the slates immediately to the southwest, west and northwest of the iron ore deposits. To the east, however, a gulch leads down to the broad valley of Whalen Canyon, which has removed the limestone and exposes the slates until they disappear beneath the tertiary rocks of the main valley.

THE IRON ORES OF SUNRISE PARK.

Copper ore was the first discovery in the Hartville district. It was solely in the search for and mining of that metal that all of the iron ore deposits of superior quality thus far found in this vicinity were detected, and whatever development has been upon them has been done only indirectly in the search for copper. During the past two years, however, iron ores in themselves have attracted attention and the development of pure iron ore in quantity upon the Chicago claim, in section 5, and of impure ore bodies that give important ideas regarding the extent of the pure deposits, have resulted. In this work a certain amount of knowledge regarding the iron ore deposits may be gathered.

Three classes of deposits may be recognized:

(1.) Lenticular masses of iron ore between walls in a crystalline slates. These are similar in nature to the hematite deposits of Michigan and Wisconsin.

(2.) Stratified deposits of usually impure hematite lying at the base of the cap rocks between the quartzite and slates.

(3.) Boulders and pebbles of hematite lying in the soil that have resulted from the denudation of the first two classes. The first form of deposit appears to be the only one of great economic importance. Ore bodies of this class are known to occur in the Sunrise, Lone Jack, Village Belle and Chicago claims. Their presence may be inferred from the tangible evidence beneath the

Republic and Fidelity and Mayflower. The theoretical probability of the occurrence of similar ore bodies beneath the cap rock in the ground between the Sunrise and Chicago claims will be referred to later.

THE SUNRISE MINE.

This is the only claim that has sufficient work done upon it to determine the course of an ore body and its thickness at even one place. At the southwestern corner of the claim, (cor. 4), the surface is literally covered with boulders and pebbles of a very pure hard hematite varying in size from a lump weighing several tons to mere grains. From this point westward the float ore suddenly disappears beneath the deep soil of the gulch bottom. Towards the east (N. 72 E.) the float may be followed towards the Sunrise main shaft in a belt about 100 feet in width. About 100 feet east of Cor. 4, and upon the Mono claim, a tunnel is run in a northerly direction to the Sunrise side line. It at first exposes a loose mass of fragments of pure hematite, then a solid face of the same ore. About 150 feet north of this point a shallow shaft shows only iron stained slates. This shaft and a tunnel west of the Sunrise claim both appear to be upon the north side of the ore body. Continuing easterly from the tunnel first mentioned the belt of float may be traced all the way to the waste dumps above the Sunrise shaft. Passing beyond the surface workings of the mine, solid masses of iron ore are exposed in the most easterly cut. Deep light soil covers the croppings beyond, but a shaft passing through near the east line of the claim shows excellent ore. Nearly on the line of the belt indicated, and directly east of this shaft there are several cuts that show some boulders of pure ore. They show no ore in place, however, but rather iron stained slate. The developments are not sufficient to show whether the cuts are on the south side of the ore chute or whether there is a turn in its course or a displacement. It is probable that a tunnel run into the hill about 200 feet N. 60 E. from these cuts would show the ore body. In other words the Sunrise ore lens may be traced upon the surface for a distance of about 900 feet and both east and west it disappears beneath a deep soil of the gulches which cross it.

The Sunrise shaft is sunk in the southern wall of the ore lens and very close to it. North of the shaft there are surface workings from which copper ore has been taken. Here two separate ores are shown. One lies entirely in the slates on the north side of the ore lens, the other wholly in the iron ore body. The first level from the shaft is 60 feet beneath the surface. Drifts have been run beneath the two surface ore bodies mentioned and through an extension of the one lying in the hematite. The latter ore body lies directly against the slates upon the north, but is elsewhere completely in hematite. The axis of this ore body runs about magnetic north and south and dips to the south so that on the north side it lies entirely above the level of the main drift,

while towards the shaft it passes below this level and suddenly plays out. The hematite in the immediate vicinity of the slope is impure, containing not only a small amount of copper, but a high percentage of silica. These impurities soon disappear and pure hematite is found in the drift on either side of the slope. The main drift from the second level, which is 110 feet beneath the surface, runs in a magnetic northerly direction and passes beneath the main slope on the first level. Two cross cuts have been driven from it, one nearly west and the other nearly east. Beginning near the shaft there is hematite. Slate appears very soon and continues for a short distance, when hematite is again encountered. From 12 or 15 feet south of the upraise to the first level, all the way along the main drift to within 20 feet of the face there is hematite. The last 20 feet of the drift is in solid slate. Close to the slate walls both north and south the hematite is not so pure as the normal ore, but from a point about 30 feet from the shaft solid hematite shows for a distance of about 90 feet along this drift. As the walls are almost vertical this would make the pure ore about 70 feet in width if measured at right angles to the course of the chute.

The drift west strikes slate in the face. The drift east is in ore all the way. The workings both of the first level and the surface show a local widening of the ore body. The maximum thickness shown is fully 150 feet, but as far as the developments go they seem to show that both east and west of the shaft the ore returns to about the width shown in the second level, and perhaps becomes somewhat narrower towards the east. But the surface indications make it certain that there is an immense body of ore extending from Cor. No. 4 of the Sunrise to the shaft near the east side of the claim, a distance of about 900 feet. Both east and west of these two points there is every reason to believe that the ore body continues unbroken, but this has never been proven or disproven by tunnels through the soil and talus.

The hematite in the immediate vicinity of the copper ore is impure, but the contents of this zone of impure ore, although large, is insignificant when compared to the entire body of hematite. Should 25 feet be deducted from the depth of the second level of the mine, to allow for the slope of the surface west and the impure ore about the copper stope, there would remain an average vertical height of 85 feet of ore above the second level of the mine. Should a width of 70 feet be assumed for the 900 feet the ore body is known to exist, the portion of the chute above this level would yield about 750,000 tons of ore. Of course, such an estimate, based upon information obtained from the slight development, is untrustworthy. Unless thorough development be made, unforseen changes in the apparent form of the ore body may occur that would largely change the figures; but as far as the development goes, the guess is a conservative one and the

actual available tonnage is more liable to prove much greater than much less.

QUALITY OF THE SUNRISE ORE.

Many analyses of this ore have been made. As far as I have seen them they all show it to be equal to the best. The following analyses were made in the office of Mr. H. B. Hodges, Engineer of Tests for the Union Pacific Railway. All but two of the samples were taken by Mr. W. P. Jenney, with whom the writer made a trip to the mines last spring. The two analyses of samples from the second level of the Sunrise shaft were taken by me in October, 1888. Since that time the level has been under water. At the west end of the claim there is much float in pieces of from a few pounds to a few tons' weight. An average sample of this ore gave:

Silica	2.40
Ferric oxide	94.42
Phosphorus	.07
Sulphur	None
Titannic acid	None
Copper	None
Metallic iron (computed)	66.09

At the main shaft several hundred feet distant much iron ore has been mined and thrown upon a dump. A sample of this ore gave:

Silica	1.90
Ferric oxide	96.50
Phosphorus	Trace
Sulphur	None
Titannic acid	None
Copper	None
Metallic iron (computed)	67.55

The ore from the bottom level of the Sunrise mine is largely hard and massive. There is also much soft micaceous ore. No. 1 of the following analyses represent the hard ore; No. 2 the soft. Both samples are averages taken from a distance of 90 feet along the main level:

	1.	2.
Water of constitution	0.47	0.25
Silica	——	13.03
Ferric oxide	88.45	83.65
Phosphorus	0.02	Trace
Sulphur	None	Trace
Titannic acid	None	Trace
Copper	None	——
Metallic iron (computed)	61.92	58.56

OTHER CLAIMS IN SUNRISE PARK.

The Lone Jack claim lies to the northeast of the Sunrise and includes the fraction between the latter mine and the Village

Belle and other ground to the north. The old tunnel and shaft upon the Lone Jack develops a body of iron ore in the slates, which scarcely appears equal in quality to the Sunrise ore, but I have no analysis of it. A small cut just north of these workings shows very fine iron ore. Since Christmas, 1889, work has been resumed in this cut. It has been widened to a face of 12 feet or more and carried further into the hill. The surface soil does not show a sign of iron as it comes from the cap rock, but it shows the characteristic red stain a few inches down, and 2 feet beneath the surface it consists entirely of fragments of hematite. Solid ore occupies the face of the cut. This is fully equal to that of the Sunrise in outward appearance and weight.

The Village Belle shaft, just across the gulch, is inaccessible. The dump shows some impure iron ore and some of excellent quality, which is discovered by analysis to be fully equal to the Sunrise ore. There can be but little doubt that the ores of the Lone Jack and Village Belle are upon the same ore lens.

Still further up the gulch, north of the workings last described, a cut exposes fine looking ore. It merely removes the soil from a face of hematite and does not penetrate it. The ore may not be in place but if not it has come from above and must come from a third parallel chute. All of the developments hitherto described show that there are three parallel ore lenses lying in the slates of Sunrise Park, and having a parallel course. The work has been done without any idea of developing the iron ores, and it is impossible to gain any idea of the width of any of them except the Sunrise lens, and that only at a few points near one vertical plane. From the appearance of the Lone Jack cut now being run the chute is a very large one.

South of the Sunrise claim, Sunrise Park is covered with a deep reddish soil, which hides the outcrop of the slates, etc. The hillsides bordering the gulches on the southeast side of the park show no large pieces of float, however, nor do the prospects there located show any pure iron ore as far as I know.

Upon the south side of the park, and well up the steep hill below the Republic tunnel, there are several rough masses of pure hard hematite, the largest probably a ton's weight, and many small pieces. This float would lead one to infer that there was another body of hematite in that vicinity. It has neither been searched for nor found.

West of the Sunrise and Mono claims, it is reasonable to infer that the Mayflower and Fidelity claims may be valuable, because should the Sunrise ore body continue unbroken and in strength to the westward it will pass directly beneath those claims.

This concludes a description of the three ore bodies that are known to exist in the slates of Sunrise Park, and also of indications that would lead to the conclusion that there is at least one other. There remains, however, one class of deposits that is interesting, not so much in itself, as it is for the inferences it yields

regarding the extent of the normal ore deposits. I refer to the second class of deposits mentioned in the early part of this report, i. e., the stratified deposits of hematite lying at the base of the cap rocks and upon the slates. This ore is usually impure and commercially worthless, as the following analysis of a sample taken from the Mayflower shows:

Water of constitution	2.00
Silica	35.50
Tenic oxide	56.00
Alumina	3.66
Phosphorus	0.44
Metallic iron (computed)	39.20

The stratum forms the bottom member of the oldest stratified rocks and was deposited in a shallow ocean bottom as the detritus washed from the denuding rocks. Water-worn boulders, some of them of ten or twenty pounds in weight, and many pebbles, attest the sedimentary character of the deposit. Higher up in the strata the percentage of hematite becomes less and less until the rock assumes the character of a pink quartzite with only occasional pebbles of pure iron ore. The predominance of hematite in this lower stratum is only local. It is not found as far as I know except in the vicinity of Sunrise Park and the Chicago claim. The important inference to be drawn is that since the major portion of this stratum is hematite the bodies of the pure iron ore from which it was denuded must be very large and occupied a great portion of the surface area in the vicinity. The New York, Black Prince, Republic, Fairview, Fidelity and Mayflower, and other claims whose names are unknown to me, cover portions of this outcrop; most of them have short tunnels driven in upon it.

THE IRON ORES UPON SECTION 5.

This locality can be but imperfectly described because the developments are so slight. The Chicago claim alone shows solid ore in place in the slate. The work done upon this claim is very slight, but is sufficient to indicate the presence of a great lens of ore. A plat of the workings, upon a scale of 50 feet to 1 inch, is inserted in this report. (Fig. 4.)

The surface does not show much float, on account of the deep soil from the steep hill above the claim, except in a gulch across the ore chute, where there are large masses of it. The upper tunnel soon encounters a loose mass of pure hematite, then solid ore and has solid ore in the face to-day. As at the Sunrise there is both hard and soft ore. The face of the tunnel has passed through a mass of the hard and is now in the softer micaceous ore. The branch tunnel passing north is also in pure ore all the way to the shaft. The bottom of the tunnel and shaft show solid ore. Mr. Jenney took two average samples of this ore, which were analyzed by Mr. Hodges. No. 1 is an average

ot the hard ore from the face; No. 2 of the soft ore from the dump.

	1.	2.
Water of constitution	0.35	0.33
Silica	9.12	11.86
Calcic oxide	———	1.17
Ferric oxide	89.08	83.03
Phosphorus	Trace	Trace
Sulphur	None	None
Copper	None	None
Titannic acid	None	None
Metallic iron (computed)	62.35	58.75

The lower tunnel upon the Chicago starts about 70 feet in an easterly direction from the upper. It passes through a mass of talus until within 6 to 8 feet of the face, when it strikes a solid mass of hard hematite in the bottom. This ore gradually rises until there is a solid face of it. The ore appears to be exceedingly pure. In the small cavities and joints there is a small amount of calc spar that will be advantageous in smelting. No slate croppings are visible near this tunnel. About a quarter of a mile down the gulch distinct croppings have a trend of to 58° E. and I have inferred this to be the direction of the ore body.

It will be seen that both of the tunnels on the Chicago strike the ore upon the outcrop and do not pass through it. Consequently neither wall of the ore body is exposed and no estimate of its actual width can be made. However, the work done indicates a minimum width of 50 feet, with neither wall found. From the Chicago claim a hill rises to the northwest at an average slope of 23½°. The cap rocks soon appear and form the floor of the plateau above.

The trend of the ore bodies in Sunrise Park is N. 72° E. At the Chicago the trend has apparently swerved northward to N. 50° E. The area between the two localities for a distance of over a mile is completely covered by perhaps 150 to 200 feet of cap rock. Any ore bodies in this area could not outcrop or be discovered by the prospector on account of the heavy covering, but it certainly seems plausible to infer that the two localities are points upon the same zone of mineral bearing slates and that between them and beneath the cap rock in the underlying slates there are other deposits of a similar nature.

The iron deposits near Hartville as to-day exposed have now been described. The Sunrise mine could prepare for an output of several hundred tons per day in a few months, and continue shipments certainly for several years to come. The Chicago claim could prepare for shipments equally as soon as the Sunrise, but as so little is known of her ore body it is not legitimate to make even a rough estimate of what the capacity of the mine would be. It can only be said that as far as developments go it promises to contain an immense body of ore of unsurpassable

quality. Should shipments be made from either or both of these two claims the stimulus given to iron mining would cause active prospecting along all of the known ore lenses and in the slates in the search for others as yet undiscovered. The belt between the Sunrise and Chicago would also be prospected by drilling through the cap rocks from the plateau. After such an extensive system of prospecting, which can only be justified by the certainty of a market, it may be predicted the district would have a greatly different appearance from that to-day. It must be remembered that the simplest typical shape of such deposits is something similar to a broad stone spear-head, and that from their thickest point they have a tendency to thin out in directions parallel to their walls. Upon such an hypothesis all the lenses that have been described, although only traced a very short distance, will extend longitudinally far beyond their present known limits. But like the stone spear-heads, each lens will vary in length and width, have sinuosities in its walls, or be broken and no definite idea of the actual shape of the ore bodies beyond the workings may be had. It can only be said that with but little development, mostly made in the search for copper ore, it has been shown that the district is now capable of furnishing a large quantity of ore and that it is possible, but not proven, that it will become celebrated as a producer along with other great hematite districts of the United States that are now furnishing their millions of tons of ore.

The low percentage of the Hartville ores in sulphur and phosphorus is remarkable. The analyses given are of average samples, each representing a large quantity of ore; none of them contain sulphur, three of them contain only a trace of phosphorus. The average of the five samples in the latter element is but 0.02 per cent. Such ore is not only adapted to the manufacture of Bessemer and open hearth steel, but may be mixed with other ores that contain too much phosphorus so that the resulting mixture may be fit for the same process of treatment. The ores do not contain appreciable quantities of manganese. The clay iron ores near Rock Creek and elsewhere along the Wyoming Division of the Union Pacific Railway contain manganese, and some of them are probably suitable for the production of a manganese pig iron that could be used in conjunction with the Hartville pig iron in the manufacture of Bessemer steel.

In closing I give an extract from a letter by Mr. G. M. Davidson, of Chicago, furnished me by Wm. Sturgis, Jr., of Cheyenne. Should the phosphorus contents of the sample he obtained have contained but 0.02 per cent. of phosphorus, the average the six samples above yields, it is easily seen how much more strongly his remarks upon the ore would apply. The extract is as follows:

"In order to give you a comparative idea of the value of these ores, I add the results of analyses of several well known Lake Superior ores, which are accounted the best to be found

along our line. These analyses I made several years ago in the laboratory of the Cambria Iron Company, the samples in each case representing shipments of the ore as received at the furnaces. The samples you sent me I have called the 'Sunrise' ore.

You understand, of course, that the product of an iron mine is not of a constant chemical composition, but varies as the mine deepens and is extended. The analyses I give of the Lake Superior ores represent those mined several years ago. The product may be different now in these mines.

In sampling an iron mine much care must be taken and considerable experience is required to obtain a sample which fairly represents the ore. If these samples from the Hartville district are a fair exposition of the body of ore as deposited in the earth, I consider it one of the best Bessemer ores to be found in this country. It is not only high in iron, but very low in phosphorus, and in my opinion would make an excellent grade of pig iron suitable for making a high grade of Bessemer or open hearth steel.

Very truly yours,

[Signed.] G. M. DAVIDSON,
Chemist."

Comparison of the "Hartville" with the best Lake Superior ores:

Name of ore.	Metalic iron.	Phosphorus.	Sulphur.
Hartville or Sunrise	68.10	0.058	2.46
Lake Superior or Quinnafac	57.94	0.053	7 69
" " Norway	52.10	0.030	12.29
" " Chapin	65.12	0.072	6.25
" " Vulcan	61.34	0.118	5.82
" " Cyclops	60.54	0.038	8.20
" " Michigamnic	57.38	0.096	7.50
" " Marquette	58.60	0.052	4.81

[Signed.] G. M. DAVIDSON,
Chemist.

THE RAWLINS HEMATITE.

No new developments have been made in this locality for a number of years. It is said by the owners of the mines worked that in all over 100,000 tons of ore were taken from their claims. Of this a part was used in the manufacture of paint; by far the larger portion was sent to Utah as a flux in silver-lead smelting.

This ore, according to Clarence King, was almost chemically pure. It occurred in irregular lenses between quartzite and limestone, and varied between a few inches and 20 feet or more in thickness. It is said that there is still a good face of ore left in one of the openings.

At a number of other places along the base of Rawlins Mountain the soil covering the strata which contains this deposit is of deep red color, and it is probable that similar deposits would

be discovered should a demand for the ore arise. Thus far there is no indication of phenomenally large bodies occurring in this district.

THE HEMATITE OF BRADLEY'S PEAK.

Bradley's Peak is the culminating point of the Seminoe Mountains. The crest of the peak consists of eruptive rocks, the southern base of metamorphic rocks carrying hematite. Lifted by a great fault into direct conjunction with the metamorphics is the Laramie or coal bearing group of rocks which lie about the base of the peak.

Upon the first visit to this locality the writer was much disappointed in what he saw compared with what he had heard of the ore bodies. It happened, however, that he did not see at that time the largest and purest deposits, and although he still does not believe that they are the largest in the world, as has been claimed for them, yet he does believe that large and valuable bodies of ore may be dicovered. The ores that he first saw were very siliceous and the deposits apparently small. But further west and across a high ridge there are some slight developments upon what appears to be large deposits of ore. It is unfortunate that the workings are of such small extent. The topography is of such a nature that a few thousand dollars expended intelligently would be sufficient to reveal the ore and the probability is that it would reveal large lenses. The south base of Bradley's Peak is composed of chloritic schists and ferruginous quartzite cut by dykes of eruptive rocks in many places. The hematite occurs in lentieular bodies in the slates and quartzites. Towards the southeast the streaks are small and as a rule contain much silica, as the following partial analysis made by Mr. Henry E. Wood, of Denver, will show:

	1.	2.
Metallic iron	55.30	29.5
Oxygen	23.91	25.50
Silica	20.10	15.00

Further to the west and across a long ridge running down the mountains there are other much larger deposits of ore. How large, the shafts and tunnels upon the ore do not show, for they do not show the walls of the deposits. Mr. A. H. Cronkite furnished me with the following analysis of ore from this locality, also made by Mr. Wood:

Metallic iron	63.56
Oxygen	27.25
Silica	2.68
Titannic acid	.03
Phosphorus	none
Manganese	none

The two following analyses were furnished me by Mr. C. P. Schoonmaker, President of the Central Association of Wyom-

ing. In forwarding them to me, he says: "As by your request, I send you with this copies of assays of iron ores taken from our mines at the Seminole Mountain, Carbon County, Wyoming, without our knowledge or consent by a man who had no monied interest in the mines."

No. 1 was made by the New York Metallurgical Works; No. 2 by Prof. Andrew S. McCreath.

Metallic iron	68.60	61.350
Manganese	——	0.042
Zinc	——	0.076
Copper	——	0.013
Sulphur	Trace	0.005
Phosphorus	None	0.046
Arsenic	——	0.006
Silica	4.30	——
Titannic acid	Trace	——
Phosphorus in 100 parts iron	None	0.075

It may be seen that all three of the last analyses given represent ores of the very finest quality.

OTHER IRON ORE DEPOSITS.

Mr. Boney Earnest recently sent me a fine piece of iron ore weighing about 150 lbs. He tells me that this ore occurs in a body 60 feet in thickness. The locality beyond that of Central Wyoming is not given. No analysis has yet been made of this ore, but I would judge that the piece sent me would yield fully 60 per cent. of metallic iron.

Magnetic iron ore has been found as float in large pieces in Crook county. Ore in place has not been found. There has been no actual search for it. The quality of this ore has not yet been determined. Clay iron ore is abundant in many places in in the shales of the Colorado group. It is so common that it attracts but little attention and little of it has been developed. There can be no doubt but that large quantities of it could be furnished should there be a demand for it. This ore occurs in irregular strata and nodules separated by clay near Rock Creek Station, upon the Union Pacific Railway. Similar deposits are described by Mr. Arnold Hayne, (Geological Explorations of the Fortieth Parallel, Vol. II, p. 150-151), as occuring in the Fort Benton cretaceous, northwest of Elk Mountain. He says:

"East of Sheep Butte and south of the Rattlesnake Road the Fort Benton Clays are characterized by an extensive development of ferruginous beds, which, in many localities, mark the underlying clay strata in these beds and nodular concretions. The clays have undergone a very considerable erosion and are cut by narrow ravines and gullies, exposing the harder iron layers along the ridges for several hundred feet in length. The following analysis made by Mr. B. E. Brewster shows it to be an argillaceous siliceous carbonate of iron with a trace of carbonaceous

matter and like many of the English clay iron-stones eontaining a eonsiderable amount of manganous oxide."

Siliea	9.74
Alumina	5.57
Ferric oxide	1.93
Terrour oxide	38.67
Manganous oxide	2.38
Lime	7.64
Magnesia	1.20
Soda and potassa	0.46
Phosphoric acid	Trace
Carbonic aeid	32.04
Water	Traee
Organic matter	Trace
	99.63

This would show the ore to contain :

Metallic iron (eomputed)	31.40
Metallic Manganese (computed)	1.83

CHAPTER III.

NOTES ON PETROLEUM FIELDS.

This subject was treated quite fully in the report of the geologist made to the tenth legislative assembly and published in the spring of 1888. This article is a very brief summary of the chapter there given, with fuller description of a new distriet.

The first discovery of natural oil springs in Wyoming dates back at least 25 years. In 1863 oil was eollected from a spring near Poison Spider Creek, and sold along the Mormon trail, for axle greasc, and a few years later it was collected from springs near Hilliard, in southern Uinta County and sold as a lubricant to the newly opened Wyoming coal mines.

But it has only been during the past deeade that the oil fields have attraeted any considerable attention; during the past five years that any borings have been made for oil. It is only now that they are deservedly exciting the interest of eastern capital and that wells are being drilled in various plaees. Petroleum is found in numerous escapes in Uinta County, near Hilliard and Fossil; in Fremont County, near Lander, in Dutton Basin and on the Stinking Water River; in Carbon County, along the base of the Rattlesnake Mountains, on Salt Creek and the South Powder; in Johnson County, on the South Powder and the No Wood Rivers; in Crook County, at various points bordering the foothills of the Black Hills Range and Bear Lodge Mountains.

In all but one of the loealities mentioned no intelligent prospecting has been carried on, and it has not been proven whether the oil exists in large quantities or not. A number of wells have

been drilled and much money expended, but, with the important exceptions to be mentioned below, the prospecting companies have been too ambitious or too careless, or both, and, instead of sinking shallow wells at first and venturing deeper as the findings would warrant, they have selected points where the "oil sands" are so far beneath the surface that they have been unable to reach them.

The most important oil field, and the only one at all developed, lies near Lander, in Fremont County.

The three wells sunk on the Popoagie all struck oil. At this place there is a small oval valley surrounded by abrupt, often precipitous hills, over which at various points he found both oil and gas escaping. A good flow of live oil was encountered in each. These wells, which varied in depths from 350 to nearly 800 feet, were cased and supplied with valves to prevent the oil from escaping, but owing to the great gas pressure a large leakage cannot be prevented—a pressure so great that upon suddenly opening the valves the oil spurts up like some black-watered geyser for 75 feet into the air. After the pipe thus clears itself the steady flow of oil is resumed, which, it is variously estimated, will aggregate from 600 to 1,000 barrels per twenty-four hours.

As these wells are about 100 miles from the nearest railroad, no oil has been shipped on account of the expense of transportation, and that oil which escapes in spite of the valves is wasted and drains into several large ponds, where there are always thousands of barrels of oil collected. Its presence is indicated long before the ponds are reached by the strong but not disagreeable smell of escaping gas.

In color this oil is black. When fresh it contains a very large amount of absorbed gas. It will yield both illuminating and lubricating oil of excellent quality when distilled, and a residue which will be used as fuel for steam making just as the residuum from the Colorado refineries is used under the boilers at the Leadville shafts.

The Shoshone wells yield oil from the top of the carboniferous formation. The rocks dip steeply into the ground both towards and away from the mountains respectively on either side of the river, but lie flat along a narrow belt, parallel to the range, and situated where the dips change. This belt passes from Beaver Creek to the Big Wind River, a distance of about 60 miles, of which over 40 miles lie within the Shoshone Indian Reservation. The oil horizon lies at various distances beneath the surface along this strip. It is never less than 500 feet beneath the ground, and never exceeds 2,000. Oil springs are found on it in a number of places.

In purchasing or locating lands, care should be taken to keep on this belt, which might be called a zone of minimum depth. On either side of the red sandstone belt, and at a short distance from it, the oil-bearing rocks are so far below the surface that

it is scarcely practicable to try to reach them with a drill. There are claims located, and several times sold, on which it would be necessary to sink a well much more than a mile in depth in order to penetrate the known oil horizon.

A well has been recently started on section 11 (?) about one and a half miles northwest of the flowing wells which are upon section 13, Tp. 32, R. 99. It has now a depth ot 400 feet. I am informed that at the well the triassic strata have a steep dip to the southwest.

Two new wells are being bored in the Rattlesnake district. One of these will have to be sunk to a depth of over 2,000 feet before the Dakota rocks are reached. The other, which is wisely located for a prospect well, has penetrated the upper Dakota sandstones.

I have not been in the Rattlesnake district since the latter well was drilled. Various rumors have been circulated regarding the actual condition of the oil sands passed through by it. That the well encountered sandstones saturated with petroleum is sure, for the same rocks outcrop a short distance to the south and are there so saturated. The latest and most reliable information I have received is to the effect that the surface at the point where the well starts is occupied by the lowest strata of the Benton shales, and that the Dakota sandstones are soon struck and that one of these strata near the top yielded oil at the rate of about a barrel an hour; but water was encountered just below the oil and both had to be cased off.

Also, that after passing below this oil stratum and through a considerable thickness of shale, another sandstone was penetrated which yielded even better prospects for a pumping well, but that the shale caved and the cable broke and the tools have not yet been removed. The only reliable and valuable information can be obtained when the tools are taken out and the oil stratum actually tested by pumping through a period of several months.

Unfortunately for the district, the prospectors, with one exception mentioned, have tried to sink deep wells, which they have been unable to complete. Had they begun with shallow wells they would long ago have determined whether or not there were any merits in the district beyond surface indications, and either abandoned the search or ventured deeper with accurate knowledge of the way to drill in this different ground, and some tangible assurance of success.

FOSSIL AND NOWOOD PETROLEUM.

I understand that promising results have been obtained from borings near Fossil, in Uinta County. But the driller is here presented with peculiar difficulties which he has as yet been unable to overcome.

The district in the vicinity of township 49, range 91, on the Nowood River, has not been visited since the boring of wells

was commenced. The oil fields of Crook County were hurriedly inspected last August. As they have not been previously reported upon, a fuller description of them will be given.

CROOK COUNTY PETROLEUM FIELD.

There are a number of points between Salt and Oil Creeks, in township 45, ranges 61 and 62, where a prominent stratum of sandstone shows indications of petroleum. I am not sure of the exact position of the oil bearing sandstone. It may be at the top of the Dakota, but is more probably near the base of the Colorado group of the cretaceous. The petroleum is found at many points as a stain and even saturating the sandstone to such an extent that the oil seeps forth in so-called springs.

All of the petroleum is found at many points as a stain in certain sandstones and even saturating such strata to such an extent that the oil seeps forth in springs. All of the oil yet found is heavy, green in color, and makes an excellent lubricator. The amount of illuminating oil it would yield is insignificant. The largest spring is in the SW.$\frac{1}{4}$ of the NE.$\frac{1}{4}$ of sec. 25, tp. 45, r. 62. The oil drains out of a porous sandstone of the Colorado group of rocks. There is a pit dug in the croppings of this stratum into which the water and oil collects. It will yield several gallons of oil daily. This oil is olive green in color by reflected light, brown by transmitted light. It has a density of $22\frac{1}{2}^\circ$ Baume. It is a superior lubricator. At the spring the strata dip from 15° to 20° SW., but further out the dip rapidly increases to over 45°.

North of the Belle Fourche River, in SE.$\frac{1}{4}$ Sec 27, Tp. 52, R. 67, the same stratum of sandstone, here much thinner than at the point just described, yields seepages of oil. The pit upon this quarter-section, when newly cleaned out, is said to yield about ninety gallons of oil per month. The oil rock dips about 12° west. Further out the dip appears to grow less.

A number of wells have been sunk in this vicinity. The Standard well, which, through chance or intention, is excellently located for a prospect well, was sunk about half a mile west of the line of outcrop of the oil sandstone. It struck this stratum at a depth of 296 feet, and pierced it 306 feet. It yielded to the pump about 20 gallons of oil in twenty-four hours. Several very shallow wells sunk along the line outcrop got very small amounts of oil.

The Great Northwestern well was started at a point about 5 miles south of the Standard, on the south bank of the Belle Fourche. It never pierced the main oil stratum because this rock outcrops to the south of it. At 155 feet a very small amount of oil was obtained from a stratum in the Dakota sandstones. From thence down to a depth of 930 feet it passed through the Dakota, Jurassic, and Upper Triassic sandstones. The money spent upon this well was little better than thrown away.

Two miles to the south of the Great Northwestern well the

Rapid City well is now in the process of sinking. At a depth of 750 feet it had not yet struck the oil sand.

It is my belief that this field may develop into a small oil district. The oil is a superior lubricator and will be valuable if obtained in quantities. The Standard well was sunk in the proper place, and the other work should be confined for the present, at least, to the same neighborhood, only the wells should be started further out from the cropping of the oil-bearing stratum. The indications are that this rock could be reached for a distance of several miles from the line of outcrop.

CHAPTER IV.

SOLUBLE SALT DEPOSITS.*

Soluble salts of two of the metals, sodium and magnesium, occur in extensive deposits in Wyoming. They are found in basins of small area which have no outlet for their drainage. They are called "lakes," because they naturally form in the lowest parts of the basins. In reality they are, with one exception, solid during all seasons of the year, and are only covered with shallow waters during the spring and early summer months.

There can be no question but that these deposits all arise through evaporation of the waters of mineral springs which feed into the lakes and have no way of escaping.

The various deposits may be classified as follows:

	Name of Deposit.	Locality.	Estimated area. Acres.
	I.—*Sulphate of sodium (Glauber's salt).*		
A	Union Pacific lakes	Albany County..	60
B	Downey lakes	do	100
C	Bothwell lakes	Carbon County..	100
D	Gill Lakes	do	80
	II.—*Sulphate and carbonate of sodium.*		
A	Morgan lake	Carbon County..	160
B	New York and Philadelphia lakes	do	150
C	Omaha lake	do	8
D	Wilmington lake	do	160
E	Wilkes Barre lake	do	50
	III.—*Pure magnesium sulphate (Epsom salt) and mixture of sodium and magnesium sulphates.*		
A	Brooklyn lake	Carbon County..	100
B	Philadelphia lake	do	40
C	Chicago lake	do	20

* Rock salt is not known to occur in Wyoming. There are numerous salt springs, notably in Crook County, on Salt Creek, and in Uinta County, on Salt River. These springs will not be described under this heading.

The estimated areas apply to the actual deposits and not to the claims. The latter are rectangular in shape and necessarily include much land not underlaid by the salts. The thickness of the deposits is variable. Along the edge it is of course very thin. Towards the center the thickness is generally unknown, but by borings or pits it is shown to be over 8, 10, even 20 feet, without the bottom being reached. Consequently no legitimate estimate can be made of the amount these deposits are capable of producing. The total area of the first two classes, excluding the Wilmington, which has no solid deposit, is 708 acres. This would yield over 30,000,000 cubic feet of sodium sulphate for each foot in thickness.

I.—*Sodium Sulphate* (*Glauber's Salt*).

A.—THE UNION PACIFIC LAKES.

The following is an extract from a letter written by Mr. Stone, formerly chemist at the Laramie Chemical Works, who was thoroughly familiar with the developments made at these deposits several years ago:

"Replying to your letter of the 5th instant, concerning the Union Pacific soda lakes, I would say that the lakes are situated southwest of Laramie about 13 miles. They are four in number, varying in size from 4 to 40 acres, and usually (always, until within three years) are dry after the middle of August. The water which floods them in the spring comes principally from the melting snow in the small basin which drains into the lakes. They are, however, fed by numerous springs, all of which, with two exceptions, send forth a strong solution of sulphate of sodium. This solution, evaporating under the influence of our dry, windy summer, deposits the salt which it holds in clear crystals, having the composition indicated in the formula $Na_2 SO_4, 10H_2 O$.

"Various soundings have been made into the deposits and measurements obtained, showing that the soda beds are in some places 40 feet deep. * * *

"In speaking of the springs mention was made of two exceptions to the soda springs. These two are very remarkable, inasmuch as they flow within a few feet of the soda and are of pure sweet water.

"The soil surrounding the lakes, as shown by excavations made at various points near the lakes, is made up in the 15 feet next to the surface, of first, a thin stratum of fine sandy gravel; second, a stratum of hard clay, which occasionally assumes a shaly appearance. This clay varies (to) from 10 to 12 feet in thickness. Below the clay is found a coarse gravel."

The composition of the soda deposits found in these lakes is remarkably uniform, the average composition being shown by the following results made in our laboratory:

Sodium sulphate	44.5
Water	54.9
Insoluble matter	.5
	99.9

The remaining 1 per cent. is made of a mixture of calcium and magnesium salts. The insoluble matter is principally organic, but usually contains silica and alumina, which have been blown upon the lakes. The water also varies in amount, but is seldom found less than 44 per cent.

A black mud is found in the soda beds, in layers of from one-half inch to 6 inches in thickness. The composition of this mud we have never determined.

The following analyses from these deposits are taken from the Mineral Resources of the United States:

	1.	2.	3.
Sulphate of soda	44.55	41.41	39.78
Water	54.98	54.79	59.66
Insoluble matter	.47	3.80	.56

From the same page the following analysis is obtained. It is probably of a sample of the "black mud" referred to by Mr. Stone:

Iron, lime, magnesia	22.33
Alumnia, soda, hydrochloric and sulphuric acids	40.82
Silica	36.85
Organic matter	Trace

B.—THE DOWNEY LAKES.

These lakes are three in number. They are located on sections 15, 22, and 21, township 13 N , range 75 W. They are between 8 and 9 miles nearly due south of the Union Pacific lakes, and are separated from the latter by the Big Laramie River. On the west there is a stream called Sandy Creek, not more than one-quarter of a mile distant. The divide between this creek and the lakes is very low—probably not over 10 feet. The area of the claims, including the lakes, aggregate 320 acres, of which over 100 acres are occupied by the soda deposits.

These deposits cover an area of over 100 acres, and contain towards the center from 7 to 9 feet of solid sodium sulphate. Analyses and practical tests at the Laramie Glass Works show the soda to be equally pure with that from the Union Pacific lakes.

C.—THE BOTHWELL LAKES.

These deposits are near the old telegraph road leading northwest from Rawlins, and about 28 miles from that town. The soda is solid and hard and pure, except for mechanically included sand. I understand that the deposits are very thick.

D.—THE GILL LAKES.

This group of lakes are situated in section 26, township 25 N., range 78 W., and is 6 miles north of the Platte River at the old Fiddleback Ranch. I have passed by the latter point twice, and did not then know of the existence of the lakes. They are four in number, and are all located in one claim of 160 acres. Of this area between 80 and 90 acres are covered by the lakes. A number of pits have been sunk to a depth of 12 feet on these lakes, and from one of this depth a hole was bored four feet deeper. The soda has never been pierced. A sample of this soda given me shows it to be very clear and pure. When freshly broken it is clear, almost transparent. The outside rapidly loses water when exposed to the air. An analysis of this soda gave the following results:

Sodium sulphate	94.50
Magnesium sulphate	2.52
Sodium chloride	0.54
Water	1.61
Undetermined and loss	.83
	100.00

This sample had necessarily been freely exposed to the air for a long time. The Gill lakes are not only important from the fact that they have very large deposits of sulphate of soda, but also because they are now within 7 miles of the railroad grade, which passes up the Platte.

II.—*Deposits of Sulphate and Carbonate of Sodium.*

A.—THE MORGAN LAKE.

The Morgan lake lies in township 28 N., range 88 W., near the northern boundary, and a few miles south of the Sweetwater River.

The pits sunk on the lake, which is dry after August, have never been deeper than 12 feet. In such pits the bottom of the soda has never been struck. Even at a distance of 75 feet from the shore the solid and pure soda is over 12 feet deep. The soda when first taken out is clear and transparent, but like all other sodas quickly effloresces. It consists of a mixture of carbonate and sulphate of soda in varying proportions, and contains little else than these salts. The samples taken from a depth of 12 feet show more sulphate than samples taken near the surface. The soda of this lake is certainly very great in quantity. Taking the area of the deposit at only 100 acres, and the thickness at but 12 feet, the contents of the deposit would be over 50,000,000 cubic feet.

The remaining deposits of this class are all situated in the Sweetwater Valley near Independence Rock. They are known as the Dupont lakes.

The Wilmington and Wilkes Barre have no solid deposits. The soda is entirely in solution. The following analysis will show the composition of these salts:

SAMPLES FROM SURFACE OF OMAHA CLAIM.

Moisture	9.01
Insoluble matter	2.61
Sulphate of soda	25.75
Chloride of sodium	2.13
Carbonate of soda	30.62
Bicarbonate of soda	30.09
Total	100.21

Dried sample from Wilkes Barre claim.

Chloride of sodium	1.83
Sulphate of soda	39.04
Carbonate of soda	59.00
Insoluble matter	9.23

Dried samples from New York and Philadelphia Claims.

Chloride of sodium	1.83	2.04	2.52
Sulphate of soda	71.37	44.74	72.40
Carbonate of soda	3.10	5.00	5.00
Insoluble matter	22.82	47.50	19.03

III.—*Magnesium sulphate (Epsom salts) and mixtures of magnesium and sodium sulphates.*

All of these deposits occur in an inclosed basin 3 miles north of Wilcox, in Carbon County. The lakes, some twenty-six in number, are scattered over the bottom of the basin, and are all contained within a space of not over 2 square miles. In size they vary from not over a fraction of an acre to nearly or quite 100 acres. Many of the twenty-six lakes are of no importance, either on account of their small size, or because they have no deposits in them. Only a few of the more important ones will be described.

A.—The Brooklyn has an area of about 100 acres. It contains a deposit of about 7 inches thick of nearly chemically normal magnesium sulphate. The analysis given below shows its composition:

Insoluble residue	0.11
Water	49.75
Sulphur trioxide	33.08
Magnesia	16.26
Sodium chloride	0.21
Sodium oxide	0.43

There are over 2,000,000 cubic feet of the pure salt in this deposit, as well as a large amount in the black mud lying beneath it, that is peculiar to soluble salt deposits.

* All of the five analyses here given are taken from the Mineral Resources of the United States, calendar year 1885; chapter on glass materials, by Joseph D. Weeks.

B.—The Philadelphia lake lies within a few hundred yards of the Brooklyn, and is separated from it by a low flat. It contains both salts, as an analysis given below will show. The deposit away from the shore is 4 to 7 feet thick :

Insoluble residue	3.38
Water	48.90
Sulphur trioxide	31.33
Magnesia	15.62
Sodium chloride	0.44
Sodium oxide	0.07

C.—The Chicago lakes form a group of which the largest is about 10 acres. The maximum thickness developed in any of them is 6 feet. Two analyses show the following composition :

	No. 1.	No. 2.
Insoluble residue	0.16	Trace.
Water	32.43	33.50
Sulphur trioxide	41.19	40.12
Magnesia	11.06	11.90
Sodium oxide	14.78	12.40

The deposits of the sulphates and of the mixtures of the sulphate and carbonate of sodium in Wyoming are of great interest and importance on account of the immense amounts in which they occur, their purity, and the fact that there is a large market for such material when facilities for placing it upon the market, namely, cheap transportation and the manufactories for using the soda at home and making products that will permit transportation to a large market, are available. Already there are important beginnings in the latter direction.

The Wyoming natural sulphate of sodium has only to be dried and it is a superior grade of the salt cake of commerce elsewhere obtained as a product of manufacture from common salt. From the salt cake, soda ash, caustic soda, and various other sodium salts are manufactured. The mixture of the sulphate and the carbonate when dried will answer all the purposes of salt cake and will be somewhat cheaper raw material for chemical works.

The average price paid for salt cake in 1885 at the glass works throughout the United States was $16.95 per long ton,* and since it is imported, for the most part, the glassworks of Illinois and in the West generally must have paid more than this by several dollars, probably over $20 per ton. When it is remembered that the Rock Springs coal is mined, the freight paid to Omaha, sold and retailed at $6.50 per ton, and that profits are made presumedly upon all these transactions, it certainly seems probable that a profit could be made by the railroads by shipping the salt cake of Laramie City to the Mississippi, a distance not much greater, and allowing it to be sold at prices which

* Mineral Resources of the United States, calendar year 1885.

would yield a fair profit to the owners and yet compete with the eastern market. Whether the railroad can do this or not will soon be seen, for Wyoming will have in the near future three separate roads well extended within her limits.

The total amount of sodium salts used in this country in 1885 cost $10,000,000. When the various deposits are reached by the railroads it seems probable that they will be able to help to supply this large market.

The only point in Wyoming where the deposits are utilized is at Laramie City, where there are chemical works for furnishing manufactured products, glassworks, and a soap manufactory. It seems to the writer than it can only be a question of a short time when these and similar enterprises will prove successful.

CHAPTER V.

NOTES ON SOME OTHER MINERAL RESOURCES OF WYOMING.

I.—*Resources of the Black Hills, Crook County.*

The Black Hills, lying for the most part in Dakota, are yet partly in Crook County, Wyo. In general type its geology is very simple, being merely an elliptical uplift, accompanied by the usual mountain sculpture, which has removed all the stratified rocks from the center and exposed the granites and schists, while the stratified rocks occur around this nucleus, in the order of their age and superposition, in belts or rings of irregular width.

In other words, the center of the hills consists essentially of granites and other crystalline rocks; and, proceeding outward toward the plains in any direction, definite belts of quartzite, limestone, red beds, sandstone, shale, and finally shales and sandstones are successively encountered, and, as they dip more steeply than the slope of the hills, each belt disappears beneath the surface and the next succeeding rock formation.

In addition to this very simple structure there is, however, another complicating feature, namely, the occurrence of numerous dikes and intrusions of eruptive rocks which cut the slates and granites in all directions and burst through the stratified rocks as high up as the top of the red beds. These eruptives in the crystalline slates of Wyoming occur only as dikes which outcrop, but do not form any prominent hills above the level of the surrounding country. But where they have burst up through the stratified rocks they form hills, even mountains.

In Wyoming, Sundance Mountain, Inyan Kara, The Devil's Tower, Black Buttes, Missouri Buttes and the Bear Lodge Mountains are all formed by such projecting masses of eruptive rock. These alone form a separate series of prominences and break the otherwise simple structure of the Black Hills uplift proper.

I have dwelt so much upon the structure of the hills because all of the various belts of rock show marked peculiarities, and with one exception may be recognized by the most careless observer. Moreover, as they differ in appearance they differ in the character of the actual and possible mineral deposits that they are liable to contain. Taking the belts in succession, the following mineral products have been found in them in quantities sufficient to attract attention:

	Class of Rock.	Mineral Substances Found.
1	Crystalline nucleus.....	Gold, tin ore, iron ore.
2	{ Quartzite / Limestone }	Lead, silver, gold.
3	Red Beds.....	Salt sp'gs, building stone, gypsum, limestone, fire-clay, coal.
4	Dakota sandstone.....	Coal, lignite, fire-clay, petroleum.
5	Colorado and Fox Hill shales and sandstone	Petroleum, clay, impure coal, clay iron ore.
6	Laramie sandstones.....	Lignite.

The crystalline nucleus.—There is a small and apparently undetached area of schists lying a little north of west of Sundance, probably in townships 51 and 52, ranges 59 and 60. Consequently the boundary line between Wyoming and South Dakota cuts through it and divides it into two portions, of which the smaller lies in Wyoming. In all it probably has an area of about 60 square miles.

These rocks are cut by a number of deep gulches, of which Beaver Creek, Potatoe and Bear Gulches (in Dakota), Sand Creek, Mallory and Spotted Tail Gulches (in Wyoming) are the most important. The most prominent mountain, Nigger Hill, lies between Bear Gulch and Sand Creek.

The rocks may be divided into two classes, schists and eruptives, the latter occurring as dikes in the former. The schists are both micaceous and chloritic. They are thoroughly crystalline, though fine grained. Their foliation is distinct and perfect. They have an average trend of magnetic north and south, and dip to the west, usually at angles between 45° and 60°. In places they contain segregated bands of quartz of considerable size. These quartz bodies lie parallel to the foliation of the schists, are very pure, white, compact and glassy, and, as far as known, do not carry appreciable quantities of gold.

The eruptive rocks are of two classes: (1) Trachytes and diorites (?), which are not known to carry any mineral of commercial importance. (2) Peculiar dikes of coarse-grained granitic rock, which carry some tin ore.

The vein tin deposits.—The granitic dikes are very abundant, and several hundred mining claims have been located upon them. They almost always lie parallel to the bedding planes of

the schists, but one instance to the contrary being noted. They vary in thickness from 2 to 50 feet, and considerable variation is sometimes evident in one and the same dike.

The vein rock consists of quartz, feldspar and mica, and is usually very coarse-grained, plates of mica several inches long being not uncommon. As accessory constituents, it contains cassiterite, tourmaline, garnet and other minerals whose exact nature have never been determined. The cassiterite occurs in imperfect crystals (rare), granules, and grains scattered through all three of the chief constituents of the matrix. Pieces as large as a hazel-nut are not uncommon, but usually it is finer, much of it being scarcely visible to the naked eye, and much of it only to be seen with the aid of a lens.

These deposits are the first of the kind the writer has ever seen, and he scarcely considers himself able to give a competent and exhaustive report upon them. Moreover, he has not yet made any tests to determine the amount of tin the vein rock may be expected to carry. It is claimed that the deposits have been examined by competent and experienced men, and that samples carefully taken yielded from 2 to 6 per cent. metallic tin; that even those taken which showed no visible cassiterite yielded from 2 to 4 per cent. of metallic tin. If this is the case, and the position of the deposits for working the enormous quantity of ore and the sufficient water supply is considered, it seems probable that in the future mines will be opened up and works erected for extraction of the ores and separation of the cassiterite from the gangue.

THE STREAM TIN DEPOSITS.

Stream tin has been found in all of the gulches that cut the granite dikes. In 1885 it was recognized by an Australian miner; before that time it was regarded as "black sand" (magnetite). Some large pieces, weighing several pounds, have been found, but most of it is in grains of small size. Some of the gulch miners have saved a part of the stream tin that has been caught with the gold in the sluice boxes, and in this way have saved a number of tons of it; and it is possible that there is sufficient to pay for working the gulch gravels, if approved methods of washing were adopted. This could be easily proved by careful tests across the gulches at different points. The stream tin is pure, and when carefully washed will yield 65 to 70 per cent. of metallic tin by a common process of reduction.

PLACER GOLD.

This district was celebrated for its rich placers and coarse gold at the time of the Black Hills excitement. All of these placers are now practically exhausted, and only a few men are still at work gleaning pay from old ground. The annual yield of both the Wyoming and Dakota gulches now amounts only to a few thousand dollars.

VEIN GOLD.

Hitherto all efforts to discover the source of the placer gold have been fruitless. Not only have no pay mines been discovered, but gold has not been found in ever so small a quantity, in deposits that might prove a common source for all the placers. On Mineral Hill in Wyoming there has been some developments made upon leads which have yielded rich assays, but thus far there are no pay mines. As far as I know no attention has been paid to certain pyritiferous eruptive rocks, whose occurrence is broad-spread over the district. These might possibly prove to be the source of the placer gold, as was largely, if not altogether, the case in California Gulch, near Leadville.

THE QUARTZITE AND LIMESTONE.

Carbonate Hill lies to the West of the Black Buttes and immediately behind them. It consists of the older stratified rocks cut through by several kinds of eruptives. Upon the west side of the hill certain siliceous limestones dip gently to the southeast until they are abruptly broken by a dike of yellow rock, probably a porphyry. Upon the line of contact between the limestone and porphyry a shaft has been sunk and a tunnel run which has produced some galena associated with a flint matrix. This is upon the Steel Galena claim. An adjoining claim called the Gray Carbonate, has a small body of excellent carbonate of lead ore lying in the limestone just east of the porphyry. About $5,000 has been expended upon this claim very foolishly, and with no idea of methodical development, with the result that little more can be seen of the nature of the deposit than was evident before work was commenced. About 40 to 50 tons of high grade lead ore have been gouged out and objectless shafts and tunnels made, but it has not been shown whether there is merely an isolated lens of ore or a deposit worthy of a small mine. In my opinion the work upon this claim should be confined to prospecting the contact between the limestone and the porphyry.

The carbonate ore will yield from 30 to 60 per cent. of lead and is said to assay from 10 to 30 ounces of silver. It would prove a very desirable smelting ore.

I have seen no other prospects for silver and lead in the Wyoming Black Hills that are worthy of the name. There is, however, quite a large area in which the quartzites and limestones are in conjunction with eruptive rocks, and I regard such contacts as favorable for the existence of ore deposits.

THE RED BEDS.

I have only space to mention the salt springs and fire-clay deposits of the Jura-Triassic formations.

Some years ago salt springs were located and evaporating pans built on Salt Creek, about 30 miles south of Sundance. The salt made was sold at the springs at $40 per ton and shipped into Deadwood. There are many springs rising over an acre or

more of ground. The brine is said to contain about 20 per cent. of salt, and estimates (not my own) place the capacity of the spring at 60 tons per day. The springs come to the surface near the top of the Triassic rocks.

Near the top of the Jurassic there is a series of clays and marls that average about 100 feet in thickness. They are very persistent and regular in their occurrence. Usually they may be easily recognized by a purple band 30 feet or more in thickness near the center. Mr. Hemingway, the superintendent of the Mount Zion coal mines, informs me that certain of these clay strata make an excellent fire brick.

This horizon of the Jurassic is also known to contain impure and thin seams of coal. As far as I have seen them they are so impure as to be worthless. Recent rumors have reached me that good coal has been found in this horizon on Hay Creek. I wait for the report to be confirmed.

The coals and petroleums of Crook County, occurring in the Dakota and Colorado groups of the Cretaceous formation, are described elsewhere under the appropriate general headings.

II.—*Resources in other portions of Wyoming.*

GOLD AND SILVER.

Little has been done in precious metal mining during the past year. Besides the gulch mining in Crook County, Mr. Emile Granier has continued his improvements in preparation for extensive hydraulic mining near Atlantic City. He is now constructing a reservoir dam at Christina Lake.

There has also been some quartz mining in the South Pass district near South Pass and Atlantic City. In this region the gold occurs in quartz segregations in chloritic schists. In past years some exceedingly rich ore bodies have been mined. I think quartz mining in this region will receive a deserved stimulus in the future.

The Keystone mine, on Douglas creek, Albany County, has recently been sold, and a stamp mill is being built and the mine opened by the new company, under the management of Mr. Wilbur C. Knight. The 20-stamp mill is nearly completed and there is a large quantity of ore upon the surface ready to be milled. It is estimated that the ore will yield a total of $20 per ton in gold.

Copper—A little more than a year ago the Sunrise mine, at Hartville, was leased and opened, and the ore extracted was smelted at Fairbank, on the Platte River. The ore in sight was worked out ot the several thousand tons which were mined, and the lease was abandoned.

The copper ore of this mine occurs in irregular masses in hematite. From the nature of the deposit it is impossible to say where another similar body occurs. Drifts run under the ore body do not show a copper stain, nor does the hematite contain

even a trace of copper. Were the iron deposits worked, it is possible that similar bodies would be found, but in what direction or how far from the old ore body it is impossible to say.

The Sparks and Green Mountain Boy claims both show good ore, the latter containing much silver. Neither of these mines has been actually developed. Many other locations are held in this vicinity. Most of them are prospectively of little value. None of them have any considerable developments. The Michigan mine, of Muskrat Canon, shows immense quantities of low-grade copper ore, with a silicious matrix. It has recently been purchased, and is now being opened up. It is proposed to begin shipments with 20 tons of ore per day, and to increase the output as the mine warrants. The ore is hauled in wagons to Lusk and there shipped to Pennsylvania by rail. It is smelted with highly basic ores.

BUILDING STONE.

The Rawlins building stone is taken from a quarry about four miles from the railroad. It occurs in immense amounts, that may be easily and cheaply taken out. The stone is of a uniform gray color, is massive, free from a tendency to cleave in any particular direction, is free from ferruginous stains and from concretions of any sort. It is soft when mined, and is an excellent working stone. It hardens on exposure and stands well in a building. It is used in Nebraska and Wyoming. The Capitol at Cheyenne is built of this stone.

A new quarry opened near Laramie furnishes brick-red and pink sandstones. I understand that the owners have a contract to deliver two car loads of this stone per week at points in Nebraska, the contract to run for ten years. Other good building stones are obtained from the carboniferous gray sandstones and drab limestones near Laramie. They furnished the stone for the University and other Laramie buildings. A handsome light gray or white sandstone is quarried near Cheyenne and used in buildings in that city. It is a fine working stone, and makes a very handsome trimming in large buildings. On Horse Creek both white and red sandstones are found. The stone is handsome and strong. Thus far little of it has been used, owing to the recentness of its discovery.

At Iron Mountain a switch has been laid to an outcrop of mas-ive gray sandstone. The rock is mined in large blocks and used by the railway company for heavy foundations.

A beautiful red sandstone, firm, even in grain, color and texture, and capable of receiving elaborate ornamental cutting, is being quarried near Glen Rock, in Converse County. Contracts have been made to deliver this stone in Omaha and Lincoln.

Building stone is also quarried as demand for it arises at many other places in Wyoming. The occurrence of excellent and handsome stone in many undeveloped localities is well known.

The great ledge of handsome red sandstone near Lander deserves especial mention.

MARBLE.

The marble deposits have never been developed. They occur in the Platte Canon district and at various points in the Laramie and Medicine Bow Mountains. From Fairbank, on the Platte River, to Muskrat Canon there are outcrops of a great belt of marble at intervals. In many places it is exceedingly silicious and contains bands and conculions of quartz. At some points it is practically free from silica. In composition it is dolomite. Though crystalline, it is very fine grained. In color it is white, pink, grayish-blue, and mottled. In most places it is cut by numerous joints and bedding planes. It occurs in the largest blocks in Muskrat Canon.

A large outcrop of dolomitic marble occurs on the Laramie River, 12 miles west of Uva. This marble is pure white, white streaked with gray, and gray. I have seen specimens weighing several hundred pounds of snowy whiteness. It is medium to coarse crystalline in texture. It is said to be massive and remarkably free from joints.

Similar marble is said to occur near Lookout Station, in Albany County, and some marble has been taken from it as specimens. The other localities have never been prospected.

GYPSUM.

The great abundance of gypsum in the red beds of the west wherever they occur is well known. It is found in thick strata, often very pure, at many places. At Laramie it is proposed to mine a large deposit of gypsum and manufacture it into plaster of Paris. A 50 ton plant is now being built for this purpose.

LIMESTONE AND SAND.

The occurrence of very pure varieties of these rocks is common. Besides the use of limestone for mortar at various points it has no demand except at Laramie, where it is used for building purposes and glass making. The limestone used for the latter purpose is obtained 3 miles east of the town. The following analysis of a sample of it was furnished by the glass company:

Calcium carbonate	98.83
Magnesium carbonate	0.45
Iron carbonate	0.12
Iron bisulphide	0.02
Alumina	0.10
Silica	0.43
Moisture	0.05
	100.00

I have no analysis of the glass sand which is taken from the

same locality. Practical tests show that it will make exceptionally white window-glass.

The limestone and sand are hauled in wagons a little over 3 miles to the glassworks. The soda is hauled 15 miles by rail. The soda as it is mined is dried and mixed in the proper proportions with the crushed limestone and unwashed sand.

ASBESTOS.

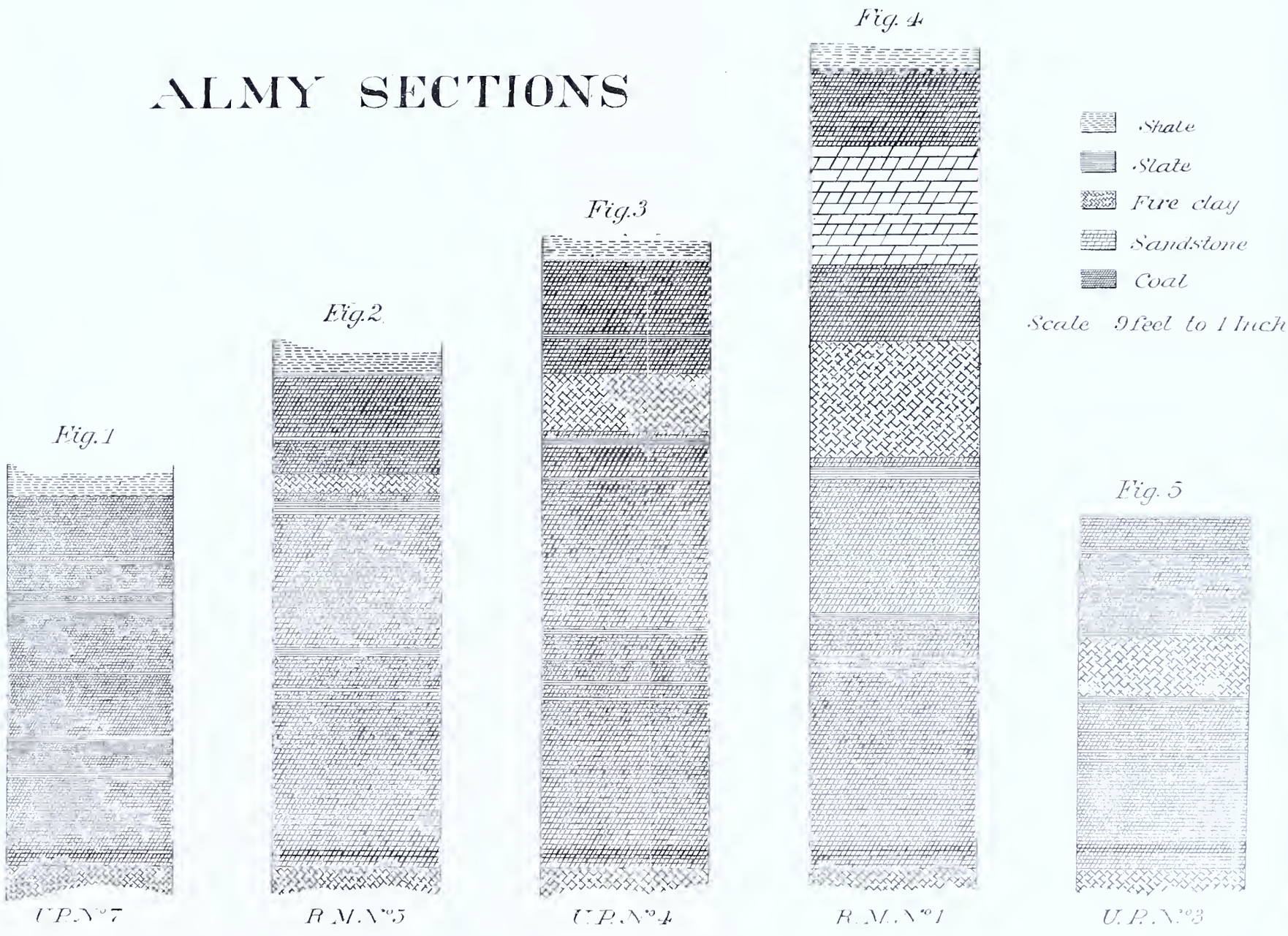
This mineral is found in the Laramie, Seminoe and Medicine Bow Mountains and elsewhere. I have received merchantable samples. The amount of the mineral that might be produced is not known.

CLAYS.

Little is known of the Wyoming clays as yet. Ordinary brick clays are everywhere abundant. Other and more valuable clays also occur in quantity. Clay from Rock Creek is now being shipped to the East, and fire brick are being made from the Mount Zion fire clays. Both of these varieties have a widespread occurrence.

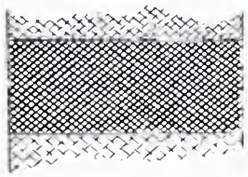
Mica, plumbago, sulphur, and other minerals are known to occur in quantities. They either have not been sufficiently developed or the writer has not examined them, and no description of them can now be given.

ALMY SECTIONS



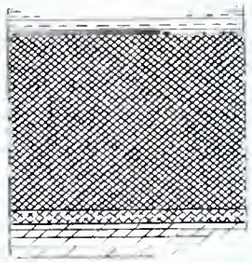
ROCK SPRINGS SECTIONS

Fig 1



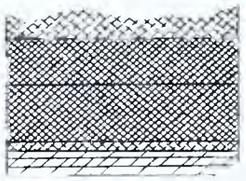
Van Dyke

Fig 2



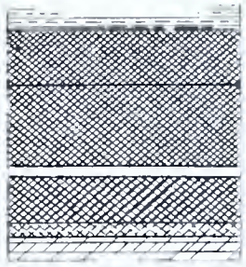
Hopkins

Fig 3



U.P. N°7

Fig 4



Prospect Sec 20

Shale

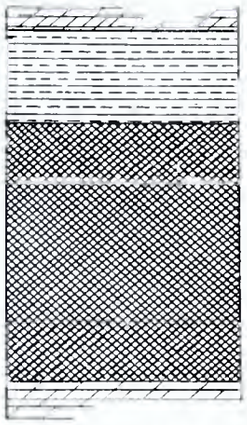
Sandstone

Fire clay

Slate

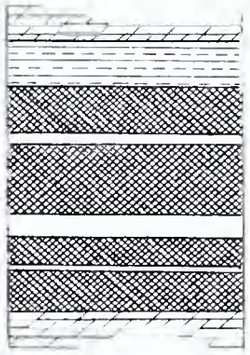
Coal

Fig 5



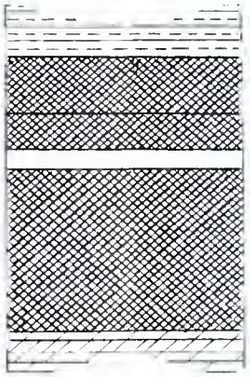
U.P. N°1

Fig 6



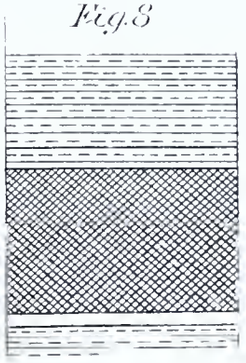
U.P. N°1

Fig 7



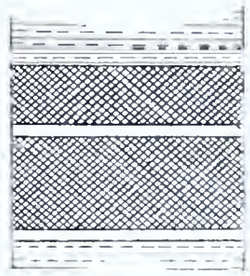
U.P. N°4

Fig 8



U.P. N°3

Fig 9



U.P. N°5

Scale: 9 feet to 1 Inch

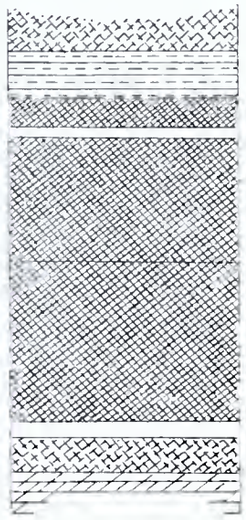
UNION PACIFIC MINES

CARBON COUNTY

WYOMING

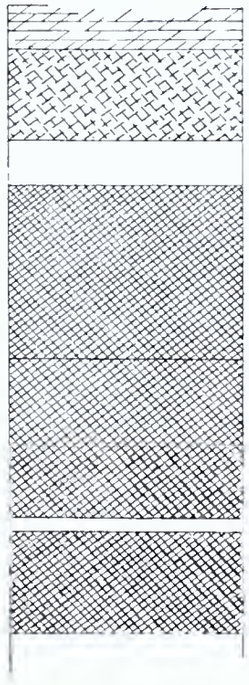
Shale
Sandstone
Fire clay
Slate
Coal

Fig. 1



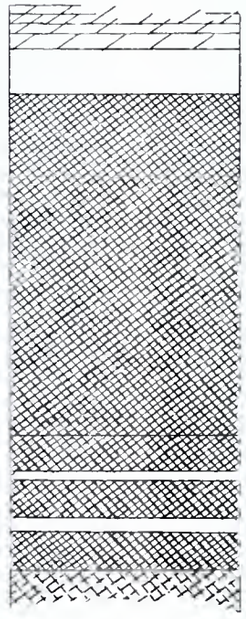
Dana

Fig. 2



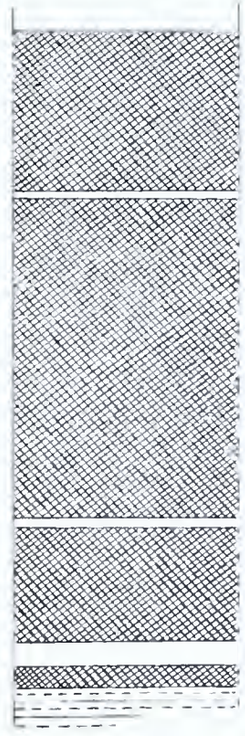
Hanna N°1

Fig. 3



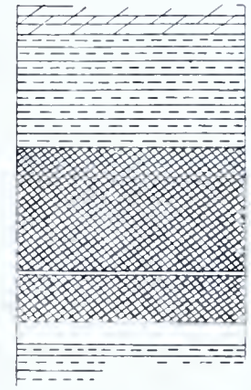
Hanna Sec. 16

Fig. 4



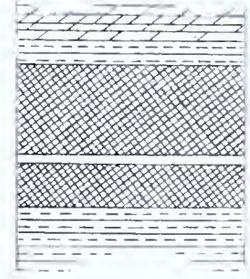
Hanna N°2

Fig. 6



Carbon N°6

Fig. 5



Carbon N°2

Scale 9 Feet to 1 Inch

CHEYENNE, WYOMING, NOV. 15, 1890.

SIR:

Upon pages fifty-nine and sixty of my report dated January, 1890, I published an extract of a letter that was furnished me purporting to be a copy of a letter written by Mr. G. M. Davidson. The copy was obtained by my friend Wm. Sturgis, Jr. from Mr. I. S. Bartlett, of Cheyenne. I am unable to state the manner in which Mr. Bartlett came into possession of the altered copy. I find that the copy furnished me had been so changed in its wording and form, and altered by insertions, that it largely misrepresented the original letter.

By reference to typewritten copies of the original letter furnished me, I find that the word "sulphur" over the third column of the table quoted should have been "silica". This error and many less serious typographical errors having crept into my report owing to the fact that I was absent from Cheyenne during the time the report was printed and was unable to attend to the proof reading. Otherwise the letter as quoted is an exact copy of the manuscript furnished me.

I am indebted to Mr. G. M. Davidson, Chemist and Engineer of Tests for the Chicago and Northwestern Railway, for informing me of the alteration of his original letter. Mr. Davidson has also furnished me with a copy of the original letter as taken from his press book. I give it in full below. Please insert this circular in the copy of my report that has been sent you.

Respectfully,

LOUIS D. RICKETTS,

Geologist for Wyoming.

CHICAGO, July 22nd, 1887.

G. W. TILTON, Esq.,
Supt. M. P. & M.

Dear Sir:

The following is the report of my analysis of the sample of iron ore found near the line of the F. E. & M. V. Ry., which you recently sent to the laboratory.

In order to give you a comparative idea of the value of this ore I add the results of analyses of several well known Lake Superior ores, many of which are found along our own line.

These analyses I made several years ago in the Laboratory of the Cambria Iron Co. The samples in each case represented shipments of the ores as received at the furnaces.

The sample you sent to me I have called F. E. & M. V. Ry. ore.

Name of Ore	Metallic Iron	Phosphorous	Silica
F. E. & M. V. Ry. ore	68.10 pr. ct.	0.058 pr. ct.	2.46 pr. ct.
Quniasec ore	57.94 "	0.053 "	7.69 "
Norway ore	52.10 "	0.010 "	12.20 "
Chapin ore	65.12 "	0.072 "	
Vulcan ore	61.84 "	0.118 "	
Cyclops ore	60.54 "	0.038 "	
Michigamme ore	57.38 "	0.096 "	
Marquette ore	58.60 "	0.052 "	4.81 "

You will understand that the product of an iron ore mine is not of constant chemical composition but varies as the mine deepens and is extended. The above analyses of Lake Superior ores represents the ore mined several years ago. The product of these mines may be different at the present time.

In sampling an iron ore great care must be taken and considerable experience is required to obtain a sample which will fairly represent the ore. It is often possible to select from a pile of ore lumps of almost pure oxide of iron but these could not be considered as fair samples.

If this sample of F. E. & M. V. Ry. ore is a fair sample of the body of the ore as deposited in the earth I consider it one of the best Bessemer ores that has been found in this country. It is not only high in iron but low in phosphorous and in my opinion would make an excellent grade of pig iron suitable for making a high grade of Bessemer or Open Hearth steel.

Very truly yours,

(SIGNED) G. M. DAVIDSON.
Chemist.

CHICAGO, ILL., Oct. 29, 1890.

The above is a true copy.

G. M. DAVIDSON.